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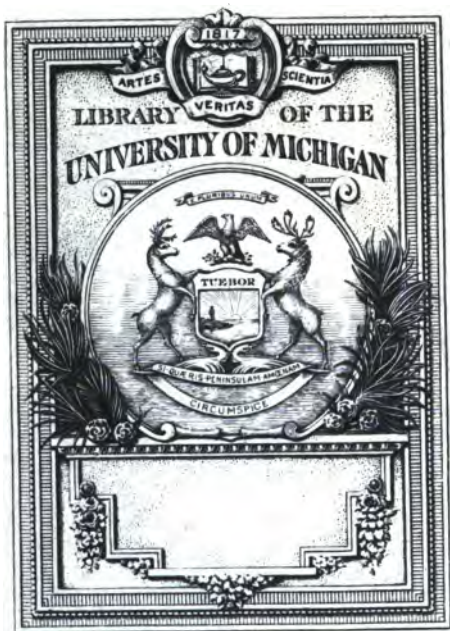
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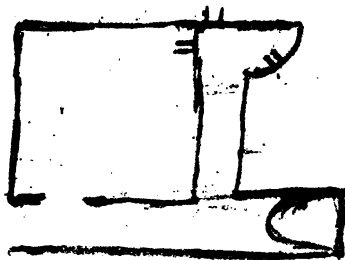
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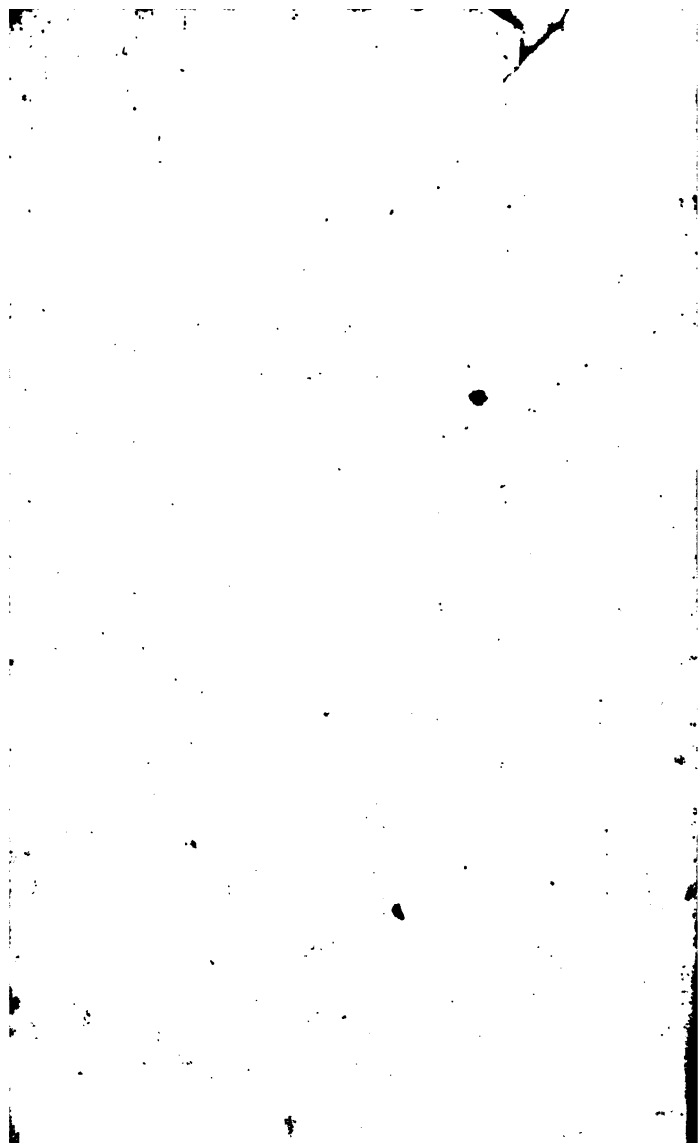
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IN FOUR
PARTS.

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- II. Fifty-five new and amazing *Paradoxes*, some in Verse, some in Prose, with their Solutions.
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P A R T I.


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G O R D O N ' S
P A R A D O X E S

S O L V ' D.

A PARADOX is a *seeming* Falsity, but a *real* Truth; 'tis that, which to *unthinking* Persons, seems absurd or impossible; but, to a *thoughtful* Man, is plain and evident: The main Drift whereof is to *whet* the Appetite of an *inquisitive* Learner, and to set him upon *Thinking*.

A 2

I. THERE

1.  *HERE are two remarkable Places, on the Globe of the Earth, in which there is only one Day and one Night throughout the whole Year.*

Answer. The two remarkable Places are the two Poles; for to the *North Pole* the *Sun* rises about the 10th of *March*. and sets not till about the 12th of *September*: and the ensuing *Twilight* continues till the *Sun* be eighteen Degrees below the *Horizon*. i. e. about the 2d of *November*. then dark *Night* continues till about the 18th of *January*. at which Time the Day breaks and the Morning *Twilight* continues 'till *Sun* rise on the 10th of *March*. Hence 'twixt *Sun* rise and *Sun* set are six Months. but betwixt Day-break and *Twilight's* End are about two Hundred and eighty eight Days, but totally dark only seventy seven Days.

Note. When it rises to the *North Pole* it sets to the *South*, & e contra; and because it rises but once and sets but once in the Year, to either, there is but one Day and one Night in the whole Year.

2. *There are also some Places on the Earth in which 'tis neither Day nor Night, at a certain Time of the Year, for the Space of twenty four Hours.*

Answer. If by neither Day nor Night. b^e meant *Twilight*, it may be any Climate of the *Frigid Zones*; but if it be understood that the *Sun* neither rises nor sets for 24 Hours, the Places must be ninety Degrees distant from the *Sun*: Thus, if the *Sun* be in the *Equator*, then the Poles are the Places; for at those Times

Times the *Sun* circuits about their *Horizon* for twenty-four Hours, half above and half under it; hence for so long, 'tis neither Day nor Night then and there: Thus also, if the *Sun* were in the *Tropic of Cancer*, ninety Degrees from which would be the *Arctic Circle*, when and where the *Sun* would be neither above nor below their *Horizon* for twenty four Hours.

3. *There is a certain Place of the Earth, at which, if two Men should chance to meet, one would stand upright upon the Soles of the other's Feet, and neither of them should feel the other's Weight, and yet they both should retain their natural Posture.*

Answer. He says of the *Earth*, not on the *Earth*, which therefore means the Center thereof; for imagine an Hole bor'd thro', from our Feet, to and thro' the Center of the *Earth*, to the opposite Point, or the *Antipodes*, and one Man descended toward the Center at one End of the Hole, and another Man descended at the other End of the Hole, till they both met at the Center, so would they stand on each other's Feet, with their Heads toward the *Zenith*, in their natural Posture without feeling each other's Weight. According to these Maxims *No heavy Body gravitates in the Center*, and *All heavy Bodies tend to the Center*; whereas a *Gravitation* at the very Center, must imply necessarily a *Divergency* from the Center, or an *Ascent*, which is absurd.

4. *There is a certain Place of the Earth, where a Fire being made, neither Flame nor Smoke would ascend, but move circularly about the Fire: Moreover, if in that Place one should fix a smooth or plain Table, without any*

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Ledges whatsoever, and pour thereon a large Quantity of Water, not one Drop thereof would run over the said Table, but would raise itself up in an Heap.

Answer. This Place must also be the Center of the Earth, for the Reasons mention'd in the last.

3. *There is a certain Place on the Globe, of a considerable Southern Latitude, that hath both the greatest and least Degree of Longitude.*

Answer. This may either mean the South Pole, which hath not only the least but greatest, and all intermediate Degrees of Longitude, all which meet in the Poles. Or all Places that lye under the first Meridian, have both the least and greatest Degree of Longitude, as at Noon is the greatest and least Number of Hours; because then and there we begin and end our Reckoning.

Thus *Trinidad* is in Latitude South, 20 Degrees, and under the first Meridian, with them who reckon from *St. Michaels's*: or *Tristam da Cunha*, is in thirty six Degrees fifty four Minutes South Latitude, and same Longitude, with *Teneriff*; all which, according to the old Way of reckoning Longitude, are not only in the Beginning of the first Degree, but also in the End of the three Hundred and sixtieth Degree of Longitude.

6. *There are three remarkable Places on the Globe that differ both in Longitude and Latitude, and yet all lye under one and the same Meridian.*

Answer. By the Globe may be meant the Artificial Globe, and by the Meridian may be meant the Brazen Meridian,

Meridian belonging to it, which may be five Degrees thick; then suppose three Places, *A, B, C*, *A* to be *Dublin*, in Latitude fifty three Degrees and an half, and Longitude twenty Degrees; *B* to be *Lisbon*, in Latitude thirty eight Degrees and an half, Longitude eighteen Degrees; *C* to be the *Isle Paxaros*, in Latitude eight Degrees, and Longitude two Hundred Degrees; all which, tho' they differ both in Longitude and Latitude, yet may they all lye under one and the same *Brazen Meridian*.

Or without Equivocation, suppose one Place under the *Pole*, a second on this Side, and a third on the other, under the same *Meridian Circle*, so may they all differ both in Longitude and Latitude; for the *Pole* contains all Degrees of Longitude.

7. *There are three remarkable Places on the Continent of Europe that lye under three different Meridians, and yet all agree both in Longitude and Latitude.*

Answer. Divers Geographers begin their first *Meridian* at divers Places; thus *Pytolomy* at *Cape Verde* (formerly one of the *Fortunate Islands*) *Mercator* at *St. Michael's* in the *Azores*; *Blaeu* at *Teneriff*, one of the *Canary Isles*, &c. Now if you take (under the same Latitude) three Places (suppose ten Degrees from each of these first *Meridians*) they agree all in Latitude, also in Longitude, from these three respective Places, and yet lye under three different *Meridians*, in respect of the *Globe*; or which is much to the same Purpose, chuse any three Places under different *Meridians*, and one Parallel of Latitude, as *Pico*, *St. Nicholas* and *Lisbon*, and begin the Longitude at every one of them; so will they all be first *Meridians*, and agree in having no Longitude and being in the same Parallel will agree also in Latitude.

Answer

8. *There is a certain Island in the Ægean Sea, upon which if two Children were brought forth at the same Instant of Time, and living together for several Years, should both expire on the same Day, yea at the same Hour and Minute of the Day, yet the Life of one would surpass the Life of the other by divers Months.*

Answer. Different Parts of the said Island may be supposed to compute differently, some by the *Solar* Year, some by the *Lunar*; or some use different Courses of the *Moon*; in one Place her *Periodical*, and in other Places her *Synodical*, which is a larger Revolution than the former; so within the Compass of some Years. the Difference will amount to several Months: Or suppose the Island to be *Negropont*, in the *Ægean* Sea, where both *Christians* and *Turks* dwell; now the *Turks* follow the *Lunar* Year, which is 11 Days less than the *Solar*, which the *Christians* account by. Now, if the Children should live thirty *Solar* Years together, and then die, the *Turks* would account them about ten Months older than the *Christians*. Or if one of the Children sails directly *East*, and the other directly *West*, when they encompass the *Globe* of the Earth, once (which is now easily done in a Year) there will be two Days Difference in their Age, and in forty Years. thus Sailing, the one would be eighty-Days older than the other. Or suppose the one lives without the *Arctic Circle*, where no Day exceeds twenty four Hours. and the other goes and lives in the Latitude of seventy three Degrees twenty Minutes, where the Day is three Months long. and then returns, and both die at one Instant, the one will be three Months older than the other; but the two first Solutions seem preferable, because of these Words in the Paradox, *living together for several Years; yet*

yet because the two last carry Instruction along with them, I would not omit the Mention of them.

9. *There are two observable Places belonging to ASIA that lye under the same Meridian, and of a small Distance from one another; and yet the respective Inhabitants of them, in reckoning their Time, do differ an intire natural Day every Week.*

Answer. This also may be solv'd two Ways, first if they keep their Sabbaths on different Days of the Week, as the *Christians* on Sunday. the *Græcians* on Monday, the *Persians* on Tuesday, the *Assyrians* on Wednesday, the *Egyptians* on Thursday, the *Turks* on Friday, the *Jews* on Saturday. Or better thus, the two Places, are, one *Macao* and the other the *Philippine Isles*, near each other and under the same Meridian, yet they differ one Day in their Account; for, in the *Philippine Isles* the *Spaniards*, when it is their last Saturday in *Lent*. the *Portuguese* in *Macao* eat Flesh, it being their first Sunday in *Easter*: The Cause of this Difference is the *Spaniards* sailed thither *Westerly*, and lost half a Day and the *Portuguese* sailed thither *Easterly* and gained half a Day.

10. *There is a particular Place of the Earth where the Winds (tho' frequently veering round the Compass) do always blow from the North Point.*

Answer. Under the *South Pole* directly; for all Winds blowing there must needs blow *North*, as all Winds blowing at the *North Pole* must needs blow *South*. because there the *Meridians*, which are *North* and *South*, are the *Azimuths* all concentring in the *Pole*, which is their *Zenith*.

II. *There*

11. *There is a certain Hill, in the South of BOHEMIA, on whose Top, if an Equinoctial Sun-Dyal be duly erected, a Man that is Stone blind may know the Hour of the Day by the same, if the Sun shines.*

Answer. Perhaps it never doth shine on that Hill' because there is a Mountain that is said to encircle all BOHEMIA, or never till Noon; so then, if you tell the blind Man the Sun shines, he'll tell you 'tis twelve o'Clock: Howbeit, I know not a better Way to make a blind Man's Sun-Dyal than this,

Fill a Glass Globe with Water, which fix in a Sphere, with twelve polish'd Iron Meridians. each having so many Nicks as the Number of Hours belonging thereto, which let be fix'd, precisely at the Distance of the Focus from the Globe, so will the Globe full of Water unite the Solar Rays that they'll burn at a Distance; thus the Equinoctial Dyal being fix'd in the Sun-shine, on a Hill or Valley. one that is Stone blind may feel which Meridian is hottest, and grope out, by the Nicks, the Number of the present Hour.

12. *There is a considerable Number of Places, lying within the Torrid Zone, in any of which, if a certain kind of Sun-Dyal be duly erected, the Shadow will go back several Degrees upon the same at a certain Time of the Year, and that twice every Day, for the Space of divers Weeks; yet no ways derogating from that miraculous returning of the Shadow upon the Dyal of Ahaz, in the Days of King Hezekiah.*

Answer.

Answer. Any where in the *Torrid Zone*, where the Latitude is less than the Declination of the Sun, and both towards the same Pole; the Sun comes twice to the same Point of the *Compass* both Forenoon and Afternoon; and an Equinoctial Dyal, placed horizontally, the Shadow of the Gnomon shall go back, *plus minus*, twice every Day. But because the Paradox mentions a certain kind of Dyal, I suppose it may be thus answer'd, by a plain Equinoctial Dyal, describ'd on both Sides of an Horizontal Plain, and with two Gnomons, and near the Tropic, when the Latitude and Declination are equal, before the Sun comes to the Mathematical Horizon in the Morning, he will shine on the lower Side of the Plain, and the Shadow of the Gnomon will run *Westward*, *ad infinitum*, and presently after six o'Clock, as he shines on the upper Plain, the Shadow runs *Eastward* till Noon, and thence to six in the Evening, at which Time the Shadow, on the lower Plain, will begin, and run *Westward* till Sun set; there may, by Concave, Convex, and Reflex Dyals, be other Ways of solving this.

Note, in the Latitude eighteen Degrees North, the Retrogradation of the Shade will continue, more or less, from the first of May to the 26th of July, i. e. eighty Days, which the Sun spends in moving from eighteen Degrees North Declination, till it come back to the same Degree again.

13. *There are divers Places on the Continent of AFRICA, and the Islands of Sumatra and Borneo, where a certain kind of Sun-Dyal being duly fix'd, the Gnomon thereof will cast no Shadow at all during several Seasons of the Year; and yet the exact Time of the Day be known thereby.*

Answer

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Answer. An Horizontal Dial, under the Equinoctial Line, casts no Shadow at twelve o'Clock, twice every Year; or because the Places mention'd in the Paradox are betwixt the Tropics, the Sun comes twice in the Year to their Zenith, and then the Gnomon casts no Shadow exactly at Noon; or it may be the blind Man's Dial aforesaid in the eleventh Paradox: But I rather take it to be a Globe, rectified according to the Latitude and Day of the Month, and the Index to the Hour twelve, and to the Sun's Place apply a perpendicular or Spheric Gnomon, which is to be there fix'd, and the Globe turn'd till it cast no Shadow, so will the Globe's Index point out the Hour any Time when the Sun shines as well in these Parts of the World as in those Islands; for Dyals may be made to shew the Hour, without Shade of either Stile or Hour Line, as a Globical Dial, having a moveable Equator, and a fix'd Stile or Gnomon thereon;

14. *There is a certain Island in the vast Atlantick Ocean, which being descry'd by a Ship at Sea, and bearing due East off the said Ship, at twelve Leagues Distance by Estimation; the truest Course for hitting the said Island, is to steer six Leagues due East, and just as many due West.*

Answer. The Prime Meridian, from whence Longitude is accounted, both Ways, East and West, passes thro' the Middle, betwixt the Ship and Island, and so Regard is had to the East and West Longitude, and not to the Points of the Compass.

There

15. *There is a remarkable Place in the Globe of the Earth, of a very pure and wholsom Air to breath in; yet of such a strange and detestable Quality, that it's absolutely impossible for two of the intirest Friends that ever breathed, to continue in the same in mutual Love and Friendship for the Space of two Minutes of Time*

Answer. 'Tis impossible for two Persons to be in one and the self same individual Place together: Others say, by reason of the Earth's Motion they cannot continue in the same Air; others say, two in the Throne cannot continue in mutual Love and Friendship; or there may be Vulcano's, Caves and Lakes, which emit sulphurous, pestilential and killing Vapours, tho' situate in a pure wholsom Air; as *SICILY*, *JUDÆA* and *ICELAND*, in which are an *Æna* or dead Sea, and in the last both; but I rather take it to be directly under the *Poles*, which, by reason of its superlative Cold, must needs have a pure Air; but we hear of none that ever got within an hundred Leagues of them, let alone to stay two Minutes there, by reason of the Mountains of Ice, frozen Sea, and excess of Cold for a thousand Miles round them.

16. *There is a certain noted Place, in the vast Atlantick Ocean, where a brisk Levant is absolutely the best Wind for a Ship that is to shape a due East Course, and yet she shall still go before it.*

Answer. If the Place be Eastward of the Levant, a Ship may be carried by an East Wind round the

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Globe to it, provided *Some East Point* be fixed; or where there is a violent *Tide*; as the *Gulf of Florida* may be meant: But the *Quibble* may lie in the *Word shape*; for an *East Wind* may be best for carrying her out of an *Harbour*, to sail to a *Place* on the *Eastern Part* of that *Island* or *Continent*; or it may mean the *Streights of Gibraltar*; for a brisk *Levant* raises the *Mediterranean*, in so much that the *Passage thro' them* is the safer, as 'tis to come into an *Harbour*, when *High Water*: Thus, if I mistake not, in the *East-India Voyages*, near or on the *Line*, a *Wind* from the *Levant* seems to be the only *Wind* to keep a *Ship* from being driven to the *African Shore*.

17. *There are divers remarkable Places, upon the Terraqueous Globe, whose sensible Horizon is commonly fair and serene; and yet 'tis impossible to distinguish properly in it any one of the intermediate Points of the Compass, nay, or so much as two of the four Cardinals themselves.*

Answer. Under either of the *Poles*, in which all the *Points of the Compass* meet in a *Center*, as aforesaid, in *Paradox 5, 10, foregoing*.

18. *There is a certain Island in the Baltick Sea, to whose Inhabitants the Body of the Sun is clearly visible, in the Morning before he Riseth, and likewise in the Evening after he is Set.*

Answer. This is occasion'd by *Refraction*, some of whose *Properties* are, 1. That oblique *Rays* out of a thinner *Medium*, falling on a grosser are re-
fracted

fracted, or accede towards the Perpendicular & fall from their Entrance. But 2^{dy}. Rays out of a grosser Medium into a thinner, recede further from the said Perpendicular. 3^{dy}. Perpendicular Rays are not refracted. 4^{thly}. The greater is the Refraction, the further the Rays are from being perpendicular. — Hence 'tis that the Sun and Stars Refraction is greater, the nearer they be to the Horizon, also the thicker the Atmosphere the greater the Refraction; as near the Poles and in the Northern Seas, as the Baltic. Refraction is useful in the first Discovery of Land upon Sea, raising the Tops of Mountains in the Air, to be seen several Leagues further off, than they would be were there no Refraction. This made the *Hollanders* in *Novi Zembla*, see the Sun rise some sixteen Days before they expected it, or would have seen it, had there been no Refraction. This also is the Reason why a Piece of Silver, which could not be seen in a Bason, yet being cover'd with Water, a thicker Medium than Air appears visible: And also, why, if a Man would shoot a Salmon under Water, he must not aim at that Point of the Water where the Ray of Sight enters, but a great Way on this Side of it; as, if the Salmon was in the Perpendicular let fall from the Point where the Ray of Sight enters the Water.

The ingenious *Lowthorp*, about 1700, gave ocular Demonstration of the Refraction, by making a Vacuum between two inclin'd Planes of Glass, by the Help of Quick-silver, thro' which an Object, view'd with a Telescope was seen, upon Re-admission of the Air, very sensibly to change Place according to the different Density thereof. See *P. Trans.* N^o 257.

19. There is a certain Village, in the Kingdom of NAPLES, situated in a very low Valley; and yet the Sun is nearer to the Inhabitants.

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habitants thereof, every Noon by three Thousand Miles and upwards, than when he either Risetb or Setteth to those of the said Village.

Answer. The Sun is nearer at Noon to the Inhabitants of any Part of the Earth, as well as *Naples*, by the Semi-diameter of the Earth; which, by the most accurate Observations yet made, is three Thousand six Hundred and ninety two *Englisb* Miles.

20. *There is a certain Village, in the South of Great-Britain, to whose Inhabitants the Body of the Sun is less visible, about the Winter Solstice, than to those who reside upon the Island of Ie*

Answer. This Village, perhaps, is near *Lewis* in *Sussex* lying under an high Mountain; there, about the Time of the *Winter Solstice*. the Sun is but a small Time visible to the Inhabitants; or some Valley or Glin surrounded with Hills, in or near *Wales*, that in the *Winter* 'tis near Noon e're the Sun approach them, and then disappears presently; whereas in an open Place in *Ireland*. or on the Top of an high Mountain, there the Sun may much sooner and much longer appear, and the more because of the greatness of Refraction, which the grossness of the Atmosphere magnifies: Moreover, in Glins, near Mountains. 'tis observable. there is least Sun-shine, because Mists are more frequent.

21. *There is a vast Country in ÆTHIOPIA SUPERIOR, to whose Inhabitants the Body of the Moon doth always appear to be most enlightned when she is least enlightned, and to be least, when most.*

Answer.

Answer. "The Light that falls upon any Body, being always in a reciprocal duplicate Ratio of the Distance from the Luminous Bodies" Hence it follows, that not only in *ÆTHIOPIA*; but in all Parts of the World, the Moon doth always appear to be most enlightned at the Full, when she's least enlightned, because she is then removed from the Sun farther than at the new Moon; by the Diameter of the Moon's Orbit, at which Time, tho' nearest to the Sun, she appears least enlightned to us, when she is, in Reality, most: Or *ÆTHIOPIA*, Interior or Superior, being situated near and under the Tropic of Capricorn, and hath Valleys surrounded with prodigious high Mountains, and the Terms, *most and least enlightned* may either respect the Moon's Body, or the Time of her shining.

1. If her Body, observe, that the Moon is as well enlightned by the Earth as the Earth by the Moon, is discover'd by Telescopes in the Hands of modern Philosophers; and neither the Ancients did, nor Moderns do question, that both receive Light from the Sun: Wherefore, at the Full, when she seems most enlightned to any one Place, she is least, in respect of her self, because then, she receives only those Rays that come directly from the Sun: But at the New Moon, when she seems least enlightned to us, she is most in respect of her self, because she receives Light from the Sun, on that Side next him, and Light from his Beams reflected from the Earth, to that Part of the Moon next us; so at Conjunction, she is, in a manner, wholly illuminated in her self, and but half in Opposition.

2. If it respect the Time of her Shining, seeing 'tis Winter in *ÆTHIOPIA*, when Summer with us, & *e contra*, they have longest Nights when ours are shortest, and the contrary; wherefore, to them the Moon will be most enlightned, or shine longest,

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when to us least, and also most to us, when least to them.

22. *There is a certain Island (whereof Mention is made by some of our latest Geographers) whose Inhabitants cannot properly be reckon'd either Male or Female, nor altogether Hermaphrodites; yet such is their peculiar Quality, that they are seldom liable unto either Hunger or Thirst, Cold or Heat, Joy or Sorrow, Hopes or Fears, or any such of the common Attendants of Life.*

Answer. If Puppets, Insects, Stones, Animalcules, Birds, Fishes or Plants, by a Catachresis may be call'd Inhabitants, then may our Author mean the Island of Parrots, situate in *Terra Australis incognita*, or any uninhabited Island, discover'd by our latest Travellers, where no other Inhabitants are, save such Plants, Fish, Stones, Insects and Animalcules.

23. *There is a remarkable Place of the Earth, of a considerable Southern Latitude, from whose Meridian the Sun removeth not for several Days, at a certain Time of the Year.*

Answer. 1. 'Tis doubtless under the *South Pole*; but, 2. Taking Sun for Sun-shine, by a Metonymy, it may intend any Place beyond the *Antarctic Circle*; and then it will not mean that the Sun stands still in the *Meridian*, but that he enlightens it for as many Days as he is above their *Horizon*; and this is usual, when we say the Sun moves not from such

* Such a Wall or Dial for so many Hours: Thus, in Latitude sixty eight Degrees South, the Sun shines upon its Meridian constantly for thirty Days.

24. *There is a certain Place of the Earth, of a considerable Northern Latitude, where tho' the Days and Nights (even when shortest) do consist of several Hours; yet in that Place it's Mid-day, or Noon, every Quarter of an Hour.*

Answer. Under the North Pole. for there every Azimuth is a Meridian. and the Sun's Course is nearly parallel to the Horizon all the Year.

25. *There are divers Places on the Globe of the Earth, where the Sun and Moon, yea and all the Planets, do actually Rise and Set according to their various Motions, but never any of the fix'd Stars.*

Answer. Under the Poles, the Planets by their Motions, get North and South Declination, consequently Rise and Set, with relation to those two Places; but the fixed Stars keeping an exact Distance from the Pole, may be said never to Rise or Set, tho' their Motion, on the Poles of the Ecliptic, may be thought some small Objection to this Paradox: Or if by divers Places, he meant many, or more than two, he may intend any Place in ENGLAND, DENMARK, or GERMANY, where Spheres are, or Pieces of artificial Clock-work, &c. shewing the Rising and Setting of the Planets, but none of the fix'd Stars.

26. *There*

26. *There is a very remarkable Place, upon the Terraqueous Globe, where all the Planets, notwithstanding their different Motions and various Aspects, do always bear upon one and the same Point of the Compass.*

Answer. Under either of the Poles, for Reasons in Paradox 5, 10, 17, 23, 24, 25; for to an Eye, situate in the North or South Pole, all the Stars, however situate, will bear on the South or North Point of the Compass, because every Azimuth becomes a Meridian, the Zenith and Pole being but one and the same Point.

27. *There is a certain noted Part of the Earth, where the Sun and Moon (ipso tempore plenilunii) may both happen to Rise at the same Instant of Time and upon the same Point of the Compass.*

Answer. Under the Poles, for Reasons in the last, to which add Refraction, which raises the Object into and above the Horizon, when 'tis considerably under the same. See Paradox 18.

28. *There is a certain Place, on the Continent of EUROPE, where, if several of the ablest Astronomers (the World now affords) should nicely observe the celestial Bodies, and that at the same Instant of Time, yet the planetary Phases and their various Aspects, would be really different to each of them.*

Answer. Some say, that neither at the Center, or any Part of the Earth, no one can observe all the Celestial Bodies at one and the same Instant of Time;

Time. 2. Others answer thus, if one of these able Astronomers shall nicely observe the Heliocentric Place of the Planets, another the Geocentric; their Phases and Aspects would be really different to each of them. Or, 3. This Paradox may respect the various Systems of the ablest Astronomers, whether *Ptolomy*, *Pythagoras* or *Tycho*, to each of whom the Planets would have both different Phases and Aspects, were they nicely observ'd in any Part of the World; because *Ptolomy* fix'd the Earth in the Center, the Sun betwixt *Venus* and *Mars*; but *Pythagoras* and *Copernicus* place the Sun in the Center of all, and the Earth betwixt *Venus* and *Mars*, and *Tycho* blending both Systems aforesaid, borrows from each, but agrees with neither; he supposing the Earth in the Center of the Sun, Moon and fix'd Stars daily to revolve on its *Axis*, and the Sun in the Center of the other five Planets, revolving about the Earth in one Year. Or, 4. By the Word *Aspects*, in this Paradox, respect may be had to the ablest Astrologers quartering and trifecting, or various Ways of erecting their Schemes of the Heavens. Suppose

				th		th	
A	{ following	Regiomontanus	{	put	Saturn	11	Venus
B		Campanus,		in the	12	Venus	9
C		Alcabitus,		in the	10	Venus	8
D		Ptolomy,		in the	10	Venus	8
				may put			and

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and Aspects would be really different to each of them, by reason of their Parallax of Sight and Situation, one seeing some Point of the same Planet hid from the Sight of the other, and on a different Point of the *Compass*.

29. *There is a large and famous Country, on the Continent of AFRICA, many of whose Inhabitants are born perfectly deaf, and others Stone blind, and continue so during their whole Lives, and yet such is the amazing Faculty of those Persons, that the Deaf are as capable to judge of Sounds as those that Hear, and the Blind of Colours as those that See.*

Answer. The Blind and Deaf have Capacity to judge of Colours and Sounds, as well as those that See and Hear; tho' they want the Senses of Seeing and Hearing: Or because the Paradox refers us to the *Continent* of AFRICA, perhaps none of them have any Judgment in Colours or Sounds, as may appear by their harsh Jargon in Speech and Music, and profound Ignorance and Stupidity in any Thing that is curious; as in *ÆTHIOPIA*, exterior, there be Cannibals, which are so extreme nasty and brutish, that they have nothing, save the Shape of Men, to lay Claim to the Character of rational Creatures: They smear themselves with stinking Grease, their Cloak is a Sheep's Skin just flead, and their Ribbons and Stockings are the Guts which they frequently feed on, as well as Human Flesh; yea and themselves, tho' so brutish and swinish, serve, as good Pork to the *Cabona's*, a worse sort of Cannibals, if possible.

There

30. *There are certain People in South AMERICA, who are properly furnish'd with only one of the five Senses, (i. e.) that of Touching; and yet they can both hear, see, taste and smell, and that as nicely as we Europeans, who have all the five.*

Answer. All the Senses are properly by the Touch: In seeing, the Object touches the *Retina*; in hearing, the Sound touches the *Drum* of the Ear; in smelling the *Effluvia's* touch the *Sensorium*; in Tasting, the *Palate*, &c. Or tho' they may have them, yet (as in the last Paradox) they being so brutish, and not knowing them, neither the right Use or Exercise of them, they may be said, not to be properly furnish'd with them; like us *when asleep*, yet when taught they can use them as nicely, as we *when awake*; so they have them in *potentia*, as a Child, yet not in *actu*, as when grown up before they be taught by others.

31. *There is a certain Country in South AMERICA, many of whose savage Inhabitants, are such unheard of Cannibals, that they not only feed upon human Flesh, but also some of them do actually eat themselves, and yet they commonly survive that strange Repast.*

Answer. If they don't eat (their *Meat*) themselves, who can eat for them, in such manner as to sustain their Life; or they may be such Brutes and Cannibals as to eat their Wives, Husbands or Children, which may be said to be Part of themselves, as being one Flesh and proceeding from them.

32. *There*

32. *There is a remarkable River on the Continent of EUROPE, over which there is a Bridge, of such a Breadth, that above three thousand Men, a-breast, may pass along upon the same, without crowding one another in the least.*

Answer. The River *Guadiana*, betwixt *Andalusia* and *Portugal*, formerly call'd *Anas*, hides it self wholly at the Town *Medelina*, and about thirty-two Miles Distance shews it self again; and *Alpheus*, a River of *ACHAIA*, runs under the Ground and Sea all the Way to *SICILY*, where, the *Grecians* say, it rises again, and is called *Arethusa*; because every fifth Year, it casts out the Dung of the Cattle that was thrown into *Alpheus*, at the Time of the Olympic Sacrifices; therefore the Land, over either of them, may not improperly be called a Bridge: Also in the County of *Warwick* there is such a Bridge: On a Common, near *Over-Ichington*, is a Pool whose Stream entreth the Ground, and after an intricate Passage, of half a Mile, cometh out again, and passeth along the Brook.

33. *There is a large and spacious Plain, in a certain Country of ASIA, able to contain six hundred thousand drawn up into Battle array; which Number of Men being actually brought thither, and there drawn up, it were absolutely impossible for any more than one single Person to stand upright upon the said Plain.*

Answer.

Answer. According to *Euclid*, a Plain can touch a Sphere only in one Point, call'd the Contact; and that See *Euclid*, by W. Whiston, *Lib. 1.* Person only who stands to that Point (with respect to the Center of that Sphere) can stand upright, and whereas the sensible

Horizon changes, as oft as we change our Place, because of the Convexity of the Earth's Periphery; And supposing each Man to stand, as perpendicular as a Plumb-line to his own Horizon; and seeing 'tis an undoubted Axiom, that *All heavy Things tend towards the Center of the Earth*, where all perpendicular Lines, if extended, would meet: These Things consider'd, I say, 'tis absolutely impossible for two Men to stand perpendicular to the same Plain, without contradicting the Axioms aforesaid; for could they stand perpendicular, then would they be parallel to each other; and were Parallels extended to the Center of the Earth, they would never meet, as all Plumb-lines so extended, would.

'Tis true, this intellectual Truth is easily demonstrated to the Mind, tho' not so easy to be mechanically prov'd to the Eye; because the Height of a Man bears no sensible Proportion to the Earth's Semidiameter. This is the longer insisted on for the Sake of the following Paradox.

34. *There is a certain European City, whose Buildings being generally of firm Stone, are (for the most part) of a prodigious Height, and exceeding strong; and yet 'tis most certain, that the Walls of those Buildings are not parallel to one another, nor perpendicular to the Plain on which they are built.*

C

Answer.

Answer. All Walls are endeavour'd to be built perpendicular to the Tangent (and point to the Center) of the Earth; where they, if continued, would meet in a Point; but if extended to the Moon and Stars, would grow wider and wider a-funder, the nearer they approach'd them; and consequently are not Parallels, which, if infinitely extended, would never meet, nor part further a-funder, but keep still the same equi-distance: Also in one Point only can a Perpendicular, to the Earth, be rais'd on an horizontal Plain, as appears by the last *Paradox*. But to be more particular; 'Tis not improbable our ingenious Author might, in this *Paradox*, intend the City of *Edinburgh*, noted for strong, high, and Stone Buildings; some being, as is reported, fourteen Stories high, built on an Hill; and therefore the Walls are not perpendicular to the Plain of the Hill, but to the Base of it; and the Walls are not parallel to each other, for the Reasons aforesaid.

35. *There is a certain City, in the Southern Part of CHINA, whose Inhabitants (both Male and Female) do observe almost the same Posture and Gate in Walking as we, Europeans; and yet they frequently appear to Strangers as if they walk'd on their Heads.*

Answer. In *CHINA* (or any other Places where the Inhabitants stand near the Sea) Strangers looking in it must see them, as tho' their Heads were downward, by the refracted Vision; Or *CHINA* being situate almost in opposite Meridians to us; and therefore, to Strangers in Geography, to tell them there are People walking with their Feet towards ours, they will ask (according to the Appearance of the Thing to them) Do they then walk on

on their Heads? for our own are uppermost, and their Heads must be under our Feet: Then whereas the *Globe* being round, all our Heads are next Heaven, and Feet next the Earth, and no upper nor under on the *Globe*, any more than on a Wheel in Motion.

36. *There are ten Places of the Earth, distant from one another three hundred Miles and upwards, and yet none of them hath either Longitude or Latitude.*

Answer. The Places are said to be of the Earth, not upon the Earth; for Longitude and Latitude are reckon'd on the Surface of the *Globe* only; so the *Axis* of the Earth, or any other imaginary Line, being above seven thousand *Italian Miles*, will not only answer this *Paradox*; but instead of ten, if he had said twenty, it would have kept within the Possibility of the Demand.

37. *There are two distinct Places of the Earth, lying under the same Meridian, whose Difference of Latitude is sixty Degrees completely; and yet the true Distance, betwixt those two Places, doth not really surpass sixty Italian Miles.*

Answer. The two Places, are not meant on the Superficies of the Earth, as you may perceive by the Word of (2nd not upon) so the Places will be so near the Center of the Earth, as two Lines, supposed to come one from no Degree of Latitude, the other from sixty Degrees of Latitude, and to meet in the Center, may approach within the Distance of sixty *Italian Miles*. Or if the Places must be on the *Globe* of the Earth, we must distinguish between Latitude when apply'd to a Country, and when

apply'd to a City; the last, is the Distance of that City from the Equator. *North* or *South*, the first is only the Breadth of a Country, from *East* to *West*: Thus, the two Countries may be *Italy* and *Germany*, which lye under the same Degree of Longitude; the Breadth, or Latitude, of *Germany*, is said to be five hundred and ten Miles, and the Breadth, or Latitude, of *Italy*, is said to be an hundred and thirty four Miles, their Difference of Breadth, or Latitude, is three hundred and seventy six Miles, or above sixty Degrees; and yet *Italy* is not sixty Miles distant from *Germany*, for they are parted but by the *Alps*.

38. *There are also two distinct Places of the Earth, lying under the Equinoctial Line, whose Difference of Longitude is completely eighty six Degrees; and yet the true Distance, between these two Places, is not full eighty six Italian Miles.*

Answer. As in the last, so in this, the Longitude of a City is its Distance *East* or *West* from the first Meridian; but the Longitude, or Length of a Country, is its Distance from *North* to *South*; Thus, suppose the Isle of *St. Thomas*, whose Longitude, or Length is not above a Degree and an half, and the Country of *ÆTHIOPIA EXTERIOR*, which is above ninety Degrees long, reckoning its Length down from *Nubia* to the Cape of *Goodhope*, and up all along the Coast of *Zanguebar*; wherefore the Difference of Longitude, or Length, may be said to be, completely, eighty six Degrees and a half, and yet the true Distance of the said Island, from the said Country, is not much above a Degree: Or the Places are not supposed on the Surface of the Earth, but nearer to the Center, where the Longitudes all coincide.

39. *There*

39. *There are three distinct Places of the Earth, all differ both in Longitude and Latitude, and distant from one another two thousand Miles completely, and yet they do all bear upon one and the same Point of the Compass.*

Answer. All Places, tho' they differ both in Longitude and Latitude, at what Distance soever, with respect to either Poles, bear upon the same Point of the Compass: Or they may be in the same Spiral Rumb, else understood as in the Earth, and not upon it. For to an Eye, situate under the $\left. \begin{matrix} \text{North} \\ \text{South} \end{matrix} \right\}$ Pole, all Places, howsoever situated, will bear on the $\left. \begin{matrix} \text{South} \\ \text{North} \end{matrix} \right\}$ Point of the Compass, because every Azimuth is a Meridian, and the Pole and Zenith coincide, as aforesaid.

40. *There are three distinct Places on the Continent of EUROPE, equidistant from one another (they making a true equilateral Triangle, each of whose Sides doth consist of a thousand Miles) and yet there is a fourth Place, so situated, in respect of the other three, that a Man may travel, on Foot, from it to any of the other three in the Space of one artificial Day, at a certain Time of the Year, and that without the least Hurry or Fatigue whatsoever.*

Answer

Answer. By an artificial Day, is meant from Sun rising to Sun setting: Now beyond the Polar Circles, and nearer to the Poles, the Days are encreased from Twenty-four Hours to Six Months, without Sun setting under the Poles, in which Time, One may travel above Four Thousand Miles and travel only a Mile an hour one with another.

Or suppose the Three Places to be in *SWEDEN*, *NORWAY* and *MUSCOVY*, where their Day is about Two Months long near the Summer Solstice, let the fourth Place be equi-distant from the other three: Now if the Sides of an Equilateral Triangle be one thousand, the Radius of its Circumscribing Circle will be five hundred seventy seven Miles: and if a Man travels but ten Miles a Day, he may readily travel from the Center of the Triangle to any of those three Places in one such Day.

41. *There are three distinct Places on the Continent of EUROPE, lying under the same Meridian, and at such a Distance, that the Latitude of the third surpasseth that of the second, by so many Degrees and Minutes, exactly, as the second surpasseth the first; and yet the true Distance of the first and third, from the second or intermediate Place, is not the same by a great many Miles.*

Answer. The oblate, spheroidical Figure of the Earth may cause such a Difference. Or suppose *London*, *Paris* and *Bourbon*. all under the same brazen Meridian, equally different in Latitude; yet the Distance of *London* from *Paris*. will exceed the Distance of *Bourbon* from *Paris*, by near an hundred Miles; because *London* is about two Degrees *Westerly*
off

off *Paris*, about the Breadth of the Brazen Meridian; whereas *Bourbon* and *Paris* are in the same Longitude, and consequently nearer, by almost two Degrees.

42. *There are two distinct Places on the Continent of EUROPE, so situated, in respect of one another, that tho' the first doth lye East from the second, yet the second is not West from the first.*

Answer. If any two Places be in the same Parallel of Latitude, respecting the Rumb, the first may and must bear off the second *East* and *West*; and yet the second, respecting the Angle of Position, or the bearing of one Place from the *Zenith* of the other, on the *Globe*, may be far short of being due *West*, as *Lisbon* in *Portugal*, and *Smyrna* in *Natolia*, are in the same Parallel of Latitude, i. e. thirty nine Degrees, and therefore, by the Rumb, they bear *East* and *West*. But on the *Globe*, *Smyrna* bears off the *Zenith* of *Lisbon* seventy five Degrees *North East*, and *Lisbon* bears off the *Zenith* of *Smyrna* eighty Degrees *South West*, which is evident from the *Globe* and Circle sailing.

Note. A Rumb-line makes equal Angles with all Meridians on the *Globe*; and an equal Part thereof altereth the Latitude equally: But the Circle of Position makes unequal Angles, i. e. greater Angles with all other Meridians than with that from which it was drawn.

43. *There is a certain European Island, the Northermost Part thereof, doth frequently alter both its Longitude and Latitude.*

Answer.

Answer. By European Island, may be meant either the Map of it, as ICELAND, whose North Part thereof, used to be set above the Arctic Circle, but now is below it, and nearer the East. Or the Island it self; then it must mean some floating Island, as Boetius tells us, there is one in Lemons, the biggest Lake in Scotland; which also our ingenious Author mentions, as one of the Rarities of Scotland; in which Lake are also Fishes without Fins, and is frequently tempestuous in a Calm: Or any Island, whose North Easterly Part is overflow'd by the Sea; this will alter both its Latitude and Longitude.

44. *There is a certain Place in the Island of Great-Britain, where the Stars are always visible, at any Time of the Day, if the Horizon be not over-cast with Clouds.*

Answer. That Place may be some Coal-pit, Well, deep Cave or high Chimney, or Dr. Halley's Royal Observatory; such as Tycho had at DENMARK; which was a deep Well or Dungeon, beset with Looking-Glasses, where he sat and observ'd the Stars, in all Seasons.

45. *It may be clearly demonstrated, by the Terrestrial Globe, that it is not above twenty four Hours Sailing, from the River Thames in ENGLAND, to the City of Messina, in SICILY, at a certain Time of the Year; provided there be a brisk North Wind, a light Frigate, and an Azimuth Compass.*

Answer. Not twenty four Hours neither, if the Voyage be perform'd on the Globe, and the Time measur'd by its Hour Index; Or if it mean the

the Tides sailing betwixt those two Places: Or because one may pass from *France* to *Italy* by Land, and the Sailing betwixt *Britain* and *France*, also *Italy* and *Sicily*, is not above twenty four Hours: Or if by twenty four Hours, be meant the natural Day unde r the *Poles*, which is a whole Year, this Voyage may be perform'd more than once in that Time: Or, Lastly, the Difference betwixt the *Julian* and *Gregorian* Accounts being eleven Days, whereunto add another, which makes twelve; a Time sufficient for such a Voyage; provided you have, still, a good Wind, light Frigate, and proper Instruments. This may easily be demonstrated by the *Terrestrial Globe*, on whose *Horizon* both Accounts are laid down.

“ These (adds our Author) are the chief Paradoxical Positions, in Matters of Geography, which mainly depend on a thorough Knowledge of the *Globe*; and though it be highly probable that they'll appear, to some, as the greatest of Fables, yet we may boldly affirm, that they are not only equally certain, with the (aforesaid) Theorems; but also we are well assured, that there's no mathematical Demonstration of *EUCLID* more infallibly true in it self, than is every one of them.

Howbeit, lest some of the foregoing Solutions should not answer the Dignity of this Encomium or Character; hear what the same ingenious Author, who doubtless knew his own Sense best, acknowledges in his Preface.

“ If therefore these Paradoxes, above-mention'd, shall obtain the End propos'd (the rousing of the Mind to Think) it matters the less, if some of them, upon strict Enquiry, should be found to consist of equivocal Terms. or, perhaps, prove little more than a Quibble at the Bottom.” To which I subjoyn, If any of the preceding

preceding Answers seem not sufficient, or satisfactory, I desire our Author's End may be still pursued: May it rouse the Mind of my judicious Reader, to *Think*, and offer a better; according to the Saying of the Poet, with which I conclude this first Part.

——— *Si quid novisti rectius istis,
Candidus imperti; Si non, his utere mecum.*



NEW



PART II.

NEW

PARADOXES

SOLV'D.



IN what Degree of Latitude
Does that soft Female dwell,
Who, upon certain Days, might view,
If she observeth well,
The Morning Sun o'th' self same Point
Of Compass twice to be,

Likewise his Evening Azimuth
Twice in the same Degrée.

Tell me sweet *English* Ladies, for you are
Than her more charming far, and far more fair.

Answer

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Answer, *Between the Tropics.* See Paradox 12.

47. In the *Atlantic* Ocean, from our Shore
Distant five hundred Leagues, or little more,
Lie the *Canary* Isles, blest with good Air,
Sweet whistling Birds, rich Winds beyond compare.
A Mountain, the World's Wonder, situate there,
One of the highest in this earthly Sphere;
By us 'tis call'd the *Teneriffa's Pike*,
Whose lofty Head 'th' Atmosphere's so high,
That it surmounts all grosser Clouds o'th' Sky;
Three Degrees and an half you may it ken,
Or (what's the same) two hundred Miles and ten;
For the Refraction, Angle you may make,
Allowance (what is thought but meet to take)
Thirty five Minutes, just of a Degree:
Now I demand what Height the Pike must be.

Answer. 4. 28. Miles high.

48. I have twelve Times seen *Bissexile*, pray tell how that can be,
Since twelve times four make forty eight, and I'm but forty three.

Answer. If a Person be born on the 25th of February, and travel Westwards the Globe about, he may see twelve *Bissexile* Years before he be completely forty four Years of Age, if he was born in a *Bissexile* Year.

49. A Golden Ball shall weigh two Pounds in Troy,
Where from th' *Æquator* ten Degrees does lye;
But at *London* a different Weight is found,
Of that same Ball, which Difference pray expound.

Answer. The Earth is not exactly round; but its Diameter at the *Equinoctial Circle*, is, to its Diameter through the *Poles*, as six hundred ninety two to six hundred eighty nine; therefore, according to the incomparable Sir Isaac Newton, the Proportion of Gravity, between the

Equator and Poles, is as five hundred to five hundred and one, and the Increase, near as the Square of the right-Sine of the Latitude; and that the Ball would weigh more at London than at ten Degrees Latitude, by thirteen Grains.

This then is (I presume) occasion'd from the Earth's oblate Figure, and the Diminution of the centripetal Force or Gravity, which is universal, 1. In every single Particle of Matter. 2. As to its Extent, 3. As to all kind of Bodies. 4. As to Time. 5. As to Quantity of Matter. 6. In a duplicate Proportion to their Distances.

50. Dic quibus hoc Animal Terræ nascatur in Oris;
Mascuhus est mater cui Mulierque patet.

*Answer. Progenitorum numerosos vire Gyrgas
Hæc rana, hic Bufo, Mater hic, illa Pater.
A Tadpole, young Frog, or Toad.*

51. Leander to his Hero writ, and she
As oft writ back, to shew her Constancy;
When with them both the Post three Times had been,
They had no more than each a Letter seen.

Answer. The Paradox means with both not each three Times: The Post first took Leander's Letter, second Hero's Answer, and third brought it to Leander.

52. The Day that I was born, my Father he
Laid by five Pounds, and said it was for me;
And when e'er my Birth-Day came, he ne'er fail'd
To add five Pounds, (his Love so much prevail'd).
At twenty four, and upon my Birth-Day,
I wedded was, my Portion he would pay.
Just thirty five Pounds (I full twenty four)
How comes it then my Portion was no more.

Answer. The Person was born in Leap Year, on the 29th of February.

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53. A certain Mount in *Devonshire* doth stand,
 Whose lofty Head o'erlooks the neighb'ring Land;
 And such is the known Property o'th' Hill,
 That if a Vessel you with Liquor fill,
 At the Hill's Top, or Vertex of the Place,
 It holds less than if filled at the Base:
 Now what's the Cause of this Deficiency,
 Pray let me know in the next Diary?

Answer. Water has its Surface always of a spherical Figure, and that farthest from the Earth's Center is least Swelling, and consequently holds least above the Brim of the Vessel: The Top Diameter of the Vessel being the Chord of a greater Circle, on the Top of an high Hill than at the Bottom, which is a somewhat less Circle, and consequently more Convex, will therefore hold more above the Brim, at the Base, than at the Top of the Mountain.

54. When Tyrant Noll, at fatal Worcester Fight,
 His Crew harangu'd, against both Law and Right,
 His quaint numerique Voice no two did hear,
 Tho' several thousand Miscreants were there;
 For ev'ry Man, and ev'ry several Ear,
 Did not the same but distant Voices hear.

Answer. Sound being effused in Concentric Circles, as a Stone falling into Water, moves it all around; so that Part of the Circle, which touch'd one Man's Ear could not touch another's, who could not be in the same individual Spot of Ground.

55. By what Means may I know most certainly,
 That two Men in the World there are,
 Whose Heads of Hair (if numbered they be)
 Are equal to a single Hair;
 Altho' some Millions on each Head there were.

Answer. If the Number in the World, do exceed
 The Number of Hairs that are on a Man's Head,
 You may safely affirm then, that two Men there are,
 That have the same Number, to a single Hair.

To explain and prove the Truth of this Hypothetical Proposition; That if there be more Persons in the World than the Number of Hairs on the Head of any one alive, then must there be two Men in the World

World, the Number of Hairs of one of whose Heads, is exactly equal (to a Hair) with those on the other's Head.

Suppose a very small Number of Men, for Instance eight, and the Hairs on none of their Heads exceed six; the same Consequence will follow by the same Ratiocination, as if you made Use of a greater.

Next, Suppose one of these eight has but one Hair, if any other of the seven have only one Hair; we have already found out what we desired; if not, set this Man by, and out of the seven remaining, chuse another, which we suppose has two Hairs; now if any one of the other six hath two Hairs, and no more, we have what we sought for; but if not, set this Man aside, and take another, out of the six remaining Men, which we suppose has three Hairs; if then any of the other five has got three Hairs, as well as he, our Enquiry is at an End; if not, set him aside, and chuse another out of the five, which we suppose has four Hairs; if any of the other four should chance to have four Hairs, then have we two Men that have each an equal Number, the Thing sought; if not, then they all four must have either five or six Hairs; for beyond six, no Man can have: Then put this Man by, and take a fifth, whom we suppose to have five Hairs, now if any of the other three have five, we have our Desire; if not, then it follows, that the three remaining Men, must of Necessity, have each Man six Hairs; for before we have proved that they had neither one, nor two, nor three, nor four, nor five, and therefore they must have six, beyond which they cannot exceed.

Now, if instead of supposing the first Man had one Hair, you had supposed he had six, five or four, &c. you would, by the same Way of Arguing, come at last to the same Conclusion.

56. *Phillis, the shy, and scornful fair,
Was by brave Strephon held most dear,
But still, as he prest on his Joy,
She grew more malepert and coy;
And when he talk'd of Marriage to her,
She got more distant from her Wooer.
But what he sur'd for, thus, in vain,
He did by Accident obtain;
For walking with his Phillis dear,
One Afternoon, to take the Air,
In a vast Champain Country, where
Nor Hedge, nor House, nor Tree were near,
When straight dark gloomy Clouds appear,
Which did preface a Storm was near.
Anon (no Shelter being nigh)
It rain'd and blow'd impetuously:*

Which made the shy Dame him invoke,
 To shelter her with his long Cloke.
 Soon after this the Storm grew higher,
 Which made the Nymph cling still the nigher:
 Then roar'd around them Peals of Thunder,
 As if the Earth had burst asunder.
 This made the trembling Maid embrace,
 And in his Bosom shrouded her Face.
 The Swain, tho' almost sm'd with Fear,
 Being thus warmly clasp'd by's Dear,
 Took Courage, and to her thus spoke,
Phillis, I all the Gods invoke,
 To witness that my Passion's true,
 And would forego the World for you;
 No Flattery I need pretend,
 For surely now the World will end.
 Oh *Strepson*! (cries the trembling Fair)
 My Thoughts I'll tell you, without Fears.
 I Love as much, as dear as you,
 But Pride forbids what Love did sue:
 And if this dreadful Storm blow o'er,
 I ne'er will persecute you more.
 Then did they intermingle Kisses,
 As sure Preface of future Bliss.
 Straightway the Heav'ns began to clear,
 And Joy succeeded now their Fear.
 This was, as I do well remember,
 About the fifth Day of *December*.
 They then agreed to be in Wedlock joy'd;
 The longest Day he in the Year could find;
 And in the following Week the Marriage was,
 Pray tell me now how this could come to pass.

Answer. From Noon to Noon, Astronomers do say
 Are not just twenty four Hours every Day.
 But longer some, some sooner haste away.

Good

Good Pendulums, as I do well remember,
 About th' eleventh or twelfth Days of December,
 The Space of thirty Seconds, measure more
 In Number, than they did the Day before;
 But no Days else, which plainly make appear
 That these the longest are in all the Year.
 Strephon rejoyc'd, that he so soon had found
 The Day on which his nuptial Joys were crown'd.
 Fair Phillis, too, transported with Delight,
 No less rejoyc'd it prov'd the longest Night.

Some Reasons follow, serving to explain the foregoing solution.

1. If the Sun or Earth moved along the Equinoctial, by a constant, uniform, equal Motion; yet the Time, from Noon to Noon, would not be exactly twenty four Hours, but twenty four Hours four Minutes; because in one Revolution the Sun would advance about one Degree further than the Day before.

2. If the Sun be supposed to move equally along the Ecciptic; yet, because of its Obliquity, equal Arches of the Ecciptic would not answer to equal Arches of the Equinoctial.

3. The Sun doth not move with a constant, uniform, equal Motion, in the Ecciptic, but sometimes faster and sometimes slower; because it moves in an Ellipsis; and in going one Half of it, spends eight Days more in the Summer than in the Winter Half Year: Therefore, it unavoidably follows, that the Days are unequal, and not exactly twenty four Hours.

97. A Landed Man two Daughters had,
 And both were very fair,
 He gave to each a Piece of Land,
 One round, the other square:
 At twenty Shillings an Acre, just,
 Each Piece its Value had,
 The Shillings which did compass each,
 For it exactly paid.
 If cross a Shilling be an Inch,
 (As it is very near)
 Which was the better Fortune, she
 That had the Round or Square?

42 New PARADOXES solv'd.

Answer. The Value of the $\left\{ \begin{array}{l} \text{Square} \\ \text{round} \end{array} \right\}$ Piece is $\begin{array}{r} 12545 \ 5 \ 7 \frac{1}{2} \\ 9853 \ 0 \ 9 \frac{3}{4} \end{array}$

Difference 2692 4 9 $\frac{3}{4}$

The Algebraic Process is,

The Perches English Measure.

In the Square.

a = Nr. of Shillings that purchas'd it.

n = Nr. of Inches about the 4 sides

f = Nr. Inch. in squ. acre = 627 2640

a = Nr. Shillings that purchas'd an Acre.

Then $\frac{a}{4}$ = one side which

squar'd gives $\frac{aa}{16}$ which

are the square Inches in the Close this divided by

n gives $\frac{aa}{16n}$ the Nr. of

Acres, which multiplied

by f gives $\frac{aaf}{16n}$ = a the

whole Value of the square Piece in Shillings, and being reduced gives

$a = \frac{16n}{f} = 12545.57 \frac{1}{2}$

In the round Piece.

a = Circumference in Inches.

a = Nr. Shillings that purchas'd it.

d = Diameter of the Circle = 1.

c = Circumf. of said Diam. 3.14159.

Then say

As c to 1 :: a = d

then $\frac{1}{2}$ Circumference into $\frac{1}{2}$ the Diameter gives the Area

$\frac{a}{2} \times \frac{d}{2} = \frac{ad}{4}$ Area.

This Area divided by n , and multiplied by f , as in the former, gives the Purchase in Shillings, viz

$\frac{aaf}{4n}$ = a which reduced is $a = \frac{4cn}{f} = 9853 : 0 : 9 \frac{3}{4}$

58. Suppose a round Ball for to move in the Air,
In a certain Proportion, which I shall declare;
Let the first Hour be twelve Miles, the next to more ten,
And so in Proportion from whence it began,
As twelve is to ten. Now try if you can
Tell the Miles it will move, suppose it to be
Continu'd in Motion to Eternity.

Answer. The Ball that is moving Eternally
In Proportion of twelve to ten justly will go,
Threescore and twelve Miles, and no more I declare, &c.

The Reason of this Paradox is, that in infinite Geometrical Progression, if
the Proportion do continually decrease, the last or least Term, will be infinitely
small, or, in Effect, nothing, and so produce a finite Number.

Suppose $A = \text{first or greatest} = 12$ is will be $\frac{12}{10} = \text{Sum of all}$
 $B = \text{second Term} = 10$ the Terms $= 72$.

59. If, in one Second's Time, an Iron Ball
Did five and twenty English half Feet fall:
How long must be the Time it then must take
A Journey of ten thousand Miles to make?

Answer. I think the Time in which the Iron Ball,
If gently dropt, ten thousand Miles will fall,
Must be allow'd in Minutes thirty four,
And Seconds nineteen, neither less nor more.

For it falls 30000 Irish Miles in 38 Minutes 38 Seconds.

This depends on the following Proposition, that the Acceleration of the
Descent of heavy Bodies, are as the Square of the Times; the Reason
is, the Action of Gravity being continu'd in every Space of Time, the falling
Body receives a new Impulse equal to what it had before, in the same Space of
Time, received from the first Power.

Thus, Suppose in the first Second of Time a Body hath acquired a Velocity,
which, in that Time, would carry it thirty two Foot (and were there no new
Force, it would continue to descend, at that Rate, with an equable Motion)
but, in the next Second of Time, the same Power of Gravity, continually
acting thereon, superadds a new Velocity equal to the former; so that at the
End of two Seconds, the Velocity is double, to what it was at the End of the
first.

44 *New PARADOXES solv'd.*

Hence, then, the Question is easily solv'd; for turn the Miles into Feet 52800000 and divide it by 12 . . 5, the Quotient is the Square of the Seconds the Body will be falling (viz. 4224000) the Square Root whereof, gives Seconds (2059) and dividing by 60, gives Minutes, namely 34: 19 Seconds a little above half an Hour.

No, Before my Father was begot,
I'm sure I was begotten,
And born before my Mother,
They both are dead and rotten:
And I am lying in that Bed
Where I got my Grandmother's Maidenhead.

Answer. Adam, I know, was ne'er begot,
And Eve of him was made,
And since by him they brought in Death:
They both, long since, are dead,
'Tis certain, Abel was begot
Of those his two said Parents,
He dy'd by Force, and was the first
That yielded to Death's Warrants:
Therefore he got the Maidenhead
Of his Grandmother, the Earth,
Being laid therein the first that was,
Tho' not the first by Birth.

61. I. As I was musing all alone,
What Paradox to pitch upon,
To entertain the Fair,
Within my Study flies a Bee,
Whose Wings made pretty Melody,
As ever I did hear.

II. Pleas'd with the Noise, I drew more nigh,
When instantly came in a Fly,
That charm'd me with her Sound;
The then united Tones produc'd
A perfect fifth, as e'er was us'd,
Or could by Art be found.

III. The

III. The nimble Fly's Wings quicker were
Than those of her Competitor,

As may by this appear;
For an acuter Tone they made,
And in a sharper Key they play'd,
(Which made the Matter clear)

IV. If in a Minute's Time, thought I,
The nimble Wings of this same Fly
Ten thousand Beats did go:
What Number then must be the Swings
In two Hour's Space, of the Bee's Wings?
Is what I fain would know.

Answer. Believe me, Sir, the little Bee
With her harmonious Wings,
Did make exact, in two Hours Space,
Eight hundred thousand Swings.

The Foundation of this depends upon the Division of a Monochord, &c. Divide the String of a Viol into three equal Parts, and then strike the whole String (and observe the Sound) stop the String again, in one of the third Parts, and strike the Length that hath two Parts of the Whole open; it will sound a perfect Fifth to the former Tone; so that the Proportion is as three to two; so is the Diapason to the Diapente, or the Musicians Eighth to their Fifth: So that the Paradox is easily answer'd; for as three to two, so is the Number of Vibrations that the Fly makes, in two Hours, to the Number which the Bee makes in the same Time, viz. 800000.

62. I once essay'd (but 'twas in vain),
To win the Prize propos'd,
Howe'er I'll venture, once again,
'Cause merrily dispos'd.
The Mark whereto I now do aim,
The promised Reward,
Eggs me to play a forced Game,
And draw my only Card;
Astonishing it sure must be
As Paradox e'er was.

And.

46 *New PARADOXES solv'd.*

And thro' Surprise you scarce can see
 How it should come to pass;
 That I, the only Offspring, then,
 Was marry'd to my Mother,
 And yet the never marry'd Man,
 Nor ever took another.
 Nay, still a stranger Thing you'll find,
 That when I wedded was,
 I then was of the Female kind,
 My Mother was the Mas;
 Yet the most fruitful Wife ne'er had
 So many Sons as I;
 'Tis hard, methinks, to be conceiv'd,
 Tho' spoke without a Lye.
 But know, the Cream o'th' Jest is here,
 No Body was my Father;
 Then wonder, yet, how't may appear
 That ever I had Mother.
 How could it ever happen so,
 I'll have you all to guess,
 And yet, perhaps, you can't find who
 My Loving Husband was.
 Here, Ladies, you may ruminate,
 And still remain in Doubt,
 Which, if you can't investigate,
 I'll dare to make all out.

*Answer. Your Paradox must needs surprise
 And much delight the Fair,
 I think you merit well the Prize,
 For 'tis beyond Compare,
 Astonish'd I found out at last
 Your meaning must be Eve,
 Being taken out of Adams Waste
 Did Female Shape receive,
 The only Off-spring then she was
 And Adam was her Mother*

*She Woman was, and he the Man,
 Yet was he not her Father,
 A fruitful Wife she was, 'tis plain
 Unto her Husband Adam,
 Her Eldest Son we read was Cain
 God knows a very bad one,
 Your Paradox thus I've explain'd
 And think 'tis du hard one,
 The Truth I hope, I have obtain'd
 If not, I beg your Pardon.*

- 63. Walking, the other Day, to take the Air,
 (Bright shone the Sun, the Weather very fair)
 At Distance I a dismal Cloud did spy,
 Which (as methought) against the Wind did fly.
 While I upon my Watch did look, to see
 How Time did pass away, lo, instantly
 A dreadful Flash of Lightning pierc'd the Cloud,
 Just fourteen Seconds, after which, aloud
 The Thunder roar'd, now I inform'd would be,
 How many Feet the Cloud did burst from me.

*Answer. When Heat, and Moisture, are in one conjoin'd,
 And sable Mountains cha'd before the Wind,
 When two contraries were together Pent,
 Their, inbred Fears, soon shew'd their discontent.
 Then mighty Jove, to scourge their Mutiny,
 Bombar'ds their Fort with his Artillery;
 For when by Force th' embodied Cloud is rent,
 A Peal of Thunder shakes the Firmament.
 See here the Distance when that Rapture brake
 When angry Jove thus to his Creatures spake,
 Hush, ceasethis Rage. They strait are calm and still,
 They all obey, and wait upon his Will.*

According to Sir Isaac Newton, Sound flies 968 Feet in
 a Second; wherefore $968 \times 14 = 13552$ Feet, or Miles 7
 6 Furlongs, 160 Feet.

Perhaps

48 New PARADOXES solv'd.

Perhaps it may not be unwelcome to the Reader to deliver some Observations concerning *Sound*: and the *Progression* of it.

Sound is produc'd by the little Vibrations, which the Parts of the sonorous Body occasions in the Air; and the *Strength* or *Weakness*; in Proportion to the Quantity of the Air struck, and the Strength of the Vibrations.

Mr. William Derham, F. R. S. observes there is a considerable Difference in the Accounts given by good Authors about the Velocity of the Motion of *Sound* in a Second of Time, as followeth.

Sir Isaac Newton's first Edition of Mathematical Principles, gives 968 Feet in a Second of Time.

His second Edition corrected _____ 1142

Francis Roberts _____ 1300

Mr. Baillie _____ 1200

Dr. Walker _____ 1131

Mr. Flamsteed Astronomer Royal _____ } 1142

Edm. Halley _____ } 1142

Mr. Derham, F. R. S. _____ } 1185

Florentine Academy _____ } 1185

Royal Academy at Paris _____ }

This Diversity proceeds, probably, from not using good Pendulums, but *Strings* and *Plumbers*. 2d. From disregarding the Winds. 3d. Distance betwixt *Sound* and *Observation* too short. And the Difference betwixt the three last being so small, might arise from using Pendulums equally good, and Experiments equally large.

The same worthy Author, by manifold Experiments, and repeated Observations, found no Difference whether the Gun was fir'd towards or against him, in the Velocity of the *Sound*, nor in any different Elevation, nor in different Quantity, or Strength of Powder (though it did in Strength of Noise) neither betwixt Day or Night, Clear or Cloudy, Winter or Summer, Rain or Snow: All kinds of *Sound* came in the same Time to his Ear, from the same Distance, whether tense or strong, languid or weak.

By very accurate Observations, he found the Motion of *Sound* to be equable in all Respects; that is, an English Mile in 2 half Seconds, 2 Miles in 18, 3 Miles in 27, &c. And he is confirm'd in the Belief, that *Sound* moves the nearest Way, and its Velocity equal in Acclivities or Declivities, and that Difference of Climates or Weather, makes no Difference in the Velocity, though thick, cloudy or snowy Weather did dull the Noise or *Sound*.

But I know not why Winds might not so affect *Sound*, that is, by conspiring with its Motion, advance it to 1200, or retard it by its being contrary, that it may not move above 1120 in a Second of Time.

The Use of all this may be to measure the Distance of Thunder, Forts, Batteries, or Ships at Sea, &c.

Any Space or Distance, proposed to find how long *Sound* will be flying that Distance, say.

As 1142 : is to 1 :: so is the Distance in Feet to the Time in Seconds.

Any

Any Time propos'd to find the Space or Distance that a Sound will fly in that Time, say,

As 1 : is to 1142 :: so is the given Time in Seconds to the Distance in Feet.

From what has been said, we may conclude, that Sound moves 1142 Feet in one Second, 8 Miles in 37 Seconds, 13 Miles in one minute *Fere*, and near 780 Miles in an Hour.

And if we number 10 Seconds between the Fire of the Cannon seen and the Sound heard, it is manifest that the Gun is 11420 Feet distant, or somewhat more than two Miles.

As likewise, if 5 Seconds pass betwixt one seeing the Flash of Lightning, and hearing the Thunder, we may reckon the Thunder-Cloud is about 5710 Feet, or a little above one Mile distant from us.

64. Enflam'd in Love and wrapt in Extacy,
Encircled in *Elixa's* Arms I lay;
When envious Chance did our sad parting cause,
Against both Nature's and Affection's Laws;
But our next Meeting, we did then assign
Seventy eight hundred Beats and twenty nine
Of a nice Pendulum, whose Length I see
Twenty five Inches three Eighth's exact to be.

Assist me quickly, oh you Sons of Art,
You who have felt the Sting of *Cupid's* Dart,
You who to Tendernefs and Pity move,
And know the Pangs of disappointed Love;
For if, too soon or late, I chance to go,
Despair and Ruin certainly ensue:
Tell me the Hours and Minutes, I implore,
Or I shall never see my dear *Elixa* more.

Answer. One Day as I was in a musing Vein,
My roving Fancy did me entertain
With Thoughts of Love, which did the Time beguile,
And great Delight attended me the while.
Straitway I struck into a verdant Plain
To meditate, and ease my troubled Brain;
There I essay'd a Grave, most rich of Shade,
Where wanton Birds harmonious Musick made:

50 New PARADOXES solv'd.

*All Things rejoyc'd in this most lovely Green,
 Nature, in full Perfection, here was seen.
 I plac'd my self under a spreading Tree,
 Methought it was a charming Canopy.
 Under this pleasant Shade Eliza sweet,
 And her dear Lover, did together meet;
 Where he oft lay encircled in her Arms,
 In Love-Transports, amidst a thousand Charms;
 But envious Chance did separate these Friends,
 Who hope next Meeting will make them amends.
 Ah! Cruel Fate, to cross poor Lovers so,
 Methinks I feel the Pain they undergo,
 Caus'd by that Traytor's Absence, in each Breast
 With Sighs and Tears which cannot be express'd.
 But lest a Disappointment he should find
 In their next Meeting, which they both assign'd,
 To ease his Pain it doth my Pity move,
 Who know the Pangs of disappointed Love.
 In his Eliza's Arms let him be blest,
 And in her pretty panting Bosom rest;
 The Time is short, which if they chance to miss,
 It puts an End to all his Earthly Bliss;
 Like a dear Lover Love my Mind inspires,
 And his hard Case a Tenderness requires:
 How long it is e're he Eliza met,
 In this most pleasant Shade, I find complete
 To be one Hour, with Minutes forty four
 And Seconds fifty six, nor less nor more.*

¶ 5. My Grandfire and my Great Grandfire,
 I'm sure, conceived were
 Both in one Instant, at one Time
 First breathed in the Air.
 My Grandfire did no sooner breath,
 My Father did the same,
 Great Grandfire my Father begot
 Before my Father came

Into this World, where he did meet
 With Troubles, not a few,
 My Family it did decrease,
 I did the same renew.
 My Grandmother and Sister too,
 Conceiv'd me, both as one:
 My Aunt and Sister, in like Case,
 Brought forth another Son.
 Tho' Grandmother and Mother too,
 Did bear me as a Son,
 My Grandmother transformed was,
 Before my Life begun;
 Though thus transformed, suffered Death,
Josephus doth relate,
 Hundreds of Years after my Birth,
 He that saw it in that Estate.

Answer. Your Paradox I must commend,
 Ingenious Mr. Lover,
 And though 'tis difficult, intend
 Solution to discover.
 'Tis Moab, who was Son of Lot,
 Your Paradox must answer,
 Which of his Daughter was begot,
 If this won't do, I can't, Sir;
 Lot, Grandfire and Great-Grandfire was
 To Moab and to his Brother,
 From hence, I think it comes to pass,
 'Tis true you mean none other;
 No Wonder they conceived were,
 (His Sire and Grandfire too)
 Both in one Instant, breath'd i'th' Air
 Together, as you shew,
 Great Grandfire Haran did beget
 His Father, Lot, we read,
 In Uz of the Chaldees, he yet,
 Long e'er Moab's Birth, was dead:

52 *New PARADOXES solv'd.*

Thus in this World, poor Lad, did meet

With Troubles manifold,

Sodom being burnt, he did retreat,

And dwelt in a strong Hold:

Laid in the Cave, being drunk with Wine,

Begot Moab and his Brother,

Of's Daughter, who as you define,

Was Sister and Grandmother.

Thus Grandmother and Mother too,

Did bear Moab as a Son,

His Grandmother, Lot's Wife, was dead,

E'er Moab's Life begun;

She was transformed into Salt,

The Scriptures plainly say,

Looking to Sodom was her Fault,

She God did disobey;

This Pillar fixed on the Earth,

Josephus doth relate,

Hundreds of Tears after Moab's Birth

He saw't in the same State.

66. *Christians the Week's first Day for Sabbath hold,*
The Jews the seventh (as they did of old)
The Turks the sixth (as I have oft been told)
Now, Good Sir, pray tell to me,
How it is possible this Thing can be,
That ever a Christian, Jew and Turk, these three,
Being altogether, in one Place may,
In and upon one and the self same Day,
Have each his own true Sabbath, tell I pray.

Answer. From the Place of the Jew's Abode let the other two set out,
The Christian East, the Turk West, and sail the Globe about,
Then with the Jew they will agree when they again do meet,
And all upon the Saturday will their true Sabbaths keep.

67. *Walking one Evening on the Sandy Shore,*
Where Shell-Fish breed, and Seas for ever roar,

I saw

I saw a Ship dance on the rolling Tide,
 With curling Smoke advancing from her Side;
 Which for some Moments my dull Sense employs,
 Before I heard the thundring Cannon's Noise.
 Then from my Fob Time's Register I drew,
 And from her Sides a second Lightning flew;
 Full fourteen Seconds of swift Time expir'd,
 Before the Sound my list'ning Ears admir'd.
 Ye learned Heads, that Sound's Progression know,
 My Distance from the floating Vessel show.

Answer. The Distance of the Ship from you was 3 English Miles, 148 Feet, or 2 Miles Irish, 2548 Feet, allowing Sound to move 1142 Feet in a Second of Time.

Note, The Sound of a Bell, in the Receiver of an Air-Pump, when the Air is exhausted, is hardly heard; nor a Gun on the Top of *Pico Teneriff*; but in an unexhausted Receiver, a small Bell may be heard many Paces off, and the further, the more the Air is compressed. These prove that Sound depends on the Vibrations of the sonorous Body on the Air.

But lest I tire any with Verse, I now return again to Prose.

68. *There are three remarkable Places, on Terraqueous Globe, to whose Inhabitants all the Stars are visible, on three certain Nights of the Year.*

Answer. Under the *Æquator*; for at the first Part of the Night you see one Hemisphere, or half of the Stars, which in twelve Hours Time entirely sets against Morning, when the other half appears that was entirely hid the Evening before: Thus there are not only three remarkable Places, but all Places under or near the *Æquator*; the best Time is when the Nights are longest, if the Places be not directly under the *Æquator*.

69. *There is a certain Place on the Earth, above whose Horizon Saturn is fifteen Years; and there is another of a considerable Distance from that, which hath Jupiter above five Years without Setting above their Horizon.*

Answer. This Place is under or near the Poles, where Saturn continues without Setting near fifteen Years; as Saturn entred Aries about the Middle of March, 1702, and passeth thro' the six following Signs, entring Libra 20th of September, 1715. which amounts to near fifteen Years; during which Time it may be supposed, that Saturn will be seen above the Horizon of the North Pole: Also the other Place (mention'd in the Paradox) of a considerable Distance, is the South Pole. where Jupiter might have been seen from March 1707, till March 1714.

70. *It may be demonstrated by the Globe, that the Sun, Moon, and several of the Planets, do not move exactly fifteen Degrees hourly, from the Meridian of several Places on the Continent of AMERICA, but come later to their Meridian than the preceding Day.*

Answer. Either it may be some floating Island; or this may arise from the diurnal Advance of the Sun, Moon and Planets in their particular Orbs, which exceed the fifteen Degrees hourly, or the three hundred and sixty Degrees of the Equinox by the said diurnal Motion of the Planets.

71. *There is a certain Wall, in the City of Dublin, whose Situation is due East and West; yet, 'tis certain, the Sun will shine on the North Side thereof before six in the Evening, all the Summer, and on the South Side before six in the Morning.*

Answer. The Wall here meant, whose Situation is due East and West, the North Side is perpendicular, the Sun having North Declination all the Summer, will shine on the North Side before six in the Evening; and the South Side of that Wall hath a reclining Plain, whose Reclination is greater than the Latitude of the Place; then may the Sun shine on that Plain before six in the Morning all the Summer.

Or thus,

The Sun being a great Body, and upon Motion, some of it will pass by the Wall before the Whole, and consequently send some of its Rays on the North Side before it be exactly six o'Clock, which is precisely when the Sun's Center is in a right Line with the Wall, which is a considerable Time after Part of it shines on the North Side, i. e. so long as the North Semidiameter of the Sun is transiting that Line of due East and West.

72. *There are several remarkable Places, above an hundred Miles asunder, which have no Antæci; and their Periæci are as far off them as their Antipodes: There are also two Places, above five hundred Miles asunder, which have no Periæci, and their Antipodes are as near them as their Antæci.*

Answer.

Answer. Those several Places an hundred Miles asunder, are all on the *Æquator*, which therefore have no *Anteci* and their *Periaci* are diametrically opposite, and are also, consequently *Antipodes*. The other two Places above five hundred Miles asunder, which have no *Periaci*, are the two *Poles*, who are both *Anteci* and *Antipodes* to each other.

73. 'Tis certainly Matter of Fact, that three certain Travellers went a Journey, in which, tho' their Heads travell'd full twelve Yards more than their Feet, yet they all returned alive, with their Heads on.

Answer. According to the Corollary of the last Proposition of the third Book of *Whiston's Euclid*. If any one should travel over the whole Circumference of the Earth, the Way gone over by his Head would exceed that which was gone over by his Feet, by the Difference of Circumferences; or by the Circumference of a Circle, whose Semidiameter is the Man's own Stature.

Now suppose *Drake*, *Cavendish*, or *Dampier*, each of them to be two Yards, then will the Diameter be four Yards, and the Circumference above twelve Yards; whereas did they ride or go on the Top-Mast, there would be still a greater Difference in each of their Voyages round the Globe.

74. Though it be generally affirm'd, that the Arch of a great Circle, betwixt two Places, is their shortest Distance; yet there are two Places so situated, as their Distance is considerably shorter than the Arch of a great Circle; yea, and there be several Places, betwixt which 'tis their longest Distance.

Answer

Answer. At the Bottom of the Ocean, some deep Cave, Valley, Mine, or some Places in the Earth, considerably below the Surface thereof; and for the latter Part, it must intend the *Antipodes*, which is the longest or greatest Distance possible.

75. *There are certain Places in North Latitude, whose longest Artificial Day, is considerably longer, by some Hours, than the longest Artificial Day with them in the same Degree of South Latitude,*

Answer. The North Pole, or near it, because the Sun spends above eight Days more in the Artificial Day, under the North Pole, betwixt *Aries* and *Libra*, than in the Artificial Day under the South Pole, betwixt *Libra* and *Aries*.

76. *Any two Places, of a considerable Distance from each other, whose Bearing is truly known, and is not on one of the Cardinal Points; yet if a Ship keep continually on the same Point, on which the Port bears off, tho' they duly rectify the Compass, and regard both Currents and Winds, it may be plainly demonstrated by the Globe, that instead of hitting it, she will be further and further off, and never will hit it on that Point*

Answer. Such is the Difference between the Angle of Position and the Rumb by the Compass, that if the Ship steers by the Compass, on the same Point
that

that the Port bears off, by the Circle of Position, it will never hit.

77. *There is a certain Place in Great-Britain, where, when the Tide is in, one may see the Sheep feeding on a certain neighbouring Island; yet when the Tide is out, and the Water at lowest, not one can be seen, tho' they be feeding there at the same Instant.*

Answer. The Place may be the Wharf of Greenwich, and the Island of Doge over against it, and the Appearance caused by the Refraction of Sight when the Water is high. See Paradox 18. ●

78. *That no Colours are real but what we call Red, Yellow, Green or Blue, &c. only appear so to us, according as Bodies variously receive their Light; and that there are no Colours in the dark.*

Answer. Nothing is so manifest to the Sense as Colour, nothing so obscure to the Understanding; which doubts whether it has a real Existence, or whether it only appears such to us, according as Bodies variously receive the Light; for we judge of them otherwise in the Twilight in the Sun, and in the Shadow, otherwise beholding them slopingly, directly, or thro' a colour'd Glass. Are any Colours fairer than those of the Rainbow, and yet they are no more real than those of the Clouds: The Whiteness we behold in the milky Way, ariseth only from the Light of many small Stars. Pictures are apprehended well or ill drawn according to their Situation: Nay, the visible Species are nothing else but Qualities streaming from every terminated

minated Body, which alter the Medium, filling the same with their Images, which they diffuse even into the Organ. Now Colours are the same, being Qualities which actually change and alter their diaphanous and illuminated Body: or the Substance of Light it-self, differently reflected from those objected Bodies, as in the Case of Prisms, &c. And to explain this Paradox more fully, extend a Yard of Scarlet Cloth, in an uniform Light, then fold it, and view one half in the Sun shine, the other half in the reflected Light, and fold it in and out, like the Paper Lanthorns of a Kite, all which diligently observe. as you move it thro' the various Degrees of Light and Shade, and you will admire the vast Variety of Colours apparent thereon, none of which are more real and inherent one than the other, only a Disposition to reflect the Varieties of Reds, as lively Carnation, Sanguine, Murry (or sable Black in the dark Shade or Absence of Light) and this Disposition arises from the Cloth being ring'd in a certain Liquor, whose minute Particles are, by reason of their Figure and Position, adapted to refract the incident Rays of Light after such Modification, as to present Red, rather Green, Blue, &c. which requires different Degrees of Refrangibility. See Newton's *Optics*

79. No Man can see the same Particle of an Object with both Eyes at once, nay not with the same Eye, if the Level of its visive Axis be changed.

Answer. This Paradox seems confirm'd both by Experience and Reason. 1. Because no Man can make the Vision of both his Eyes equally perfect; but beholding a Thing first with one Eye, the other being closed, shall constantly discover it to be greater.

greater in Dimensions, in the Apprehension of one Eye than of the other. So *Gassendus*, Epist. 2. Sect. 17. testifies that the Characters of his Book appear'd to his right Eye, by one fifth Part, greater in Dimensions, tho' somewhat more obscure, than to his left. 2dly, Because of all twin Parts of the Body, one is always more perfect and vigorous than the other, which, if not the Effect of Custom, may proceed from a more liberal Afflux of Spirits to one than the other: or the organical Constitution may vary a little, as if one Pupil be wider, the Chrystaline more Convex, &c. Such like Causes necessitate a respective Disparity in the Action.

80. *The same Object speculated by the same Man, at the same Distance, and in the same Degree of Light, doth always appear greater to one Eye than the other; and that all Men see distinctly but with one Eye at once, contrary to that Axiom, That the visive Axes of both Eyes concur and unite in the Object.*

Answer. Notwithstanding the Repugnancy of this Paradox to common Opinion, yet its Verity ought to be asserted; for the Axes of the Eyes were so ordain'd by Nature, that when one is intended the other is relaxed, nor can they be both employ'd at once, tho' both at once may be relaxed, because of the Parallelism of the Motion of the Eyes, which is evident to Sense: Nor is there more Necessity to use both Eyes, than both Arms or Legs at once; for Instance, look but at the Top of your own Nose, and you will be soon convinc'd that you cannot discern it with both Eyes at once, but the right Side with the right Eye, and the left Side with the left Eye; for when the *Axis* of the right Eye is converted

verted to the right Side of the Nose, the *Axe* of the left must be converted towards the left Ear. For a further Illustration, in the Chamber set up a Staff, retreat a few Feet, and fix your Head against the Wall, then see what Pane of Glass, or Part thereof the Staff hides from the right Eye, when the left is shut; also, without moving the Head, shut the right Eye and open the left, and see what Part of the Pane is then hid, which will be very different from the former, and their Distance asunder is called the Parallax of Sight; then open both Eyes, and view if the *Axes* of both did meet and unite in the Staff, as is generally supposed, then, of Necessity, would you observe the Staff to eclipse either both Parts of the Window together, or the Middle of the *Parallax*; but you shall observe it to do neither, but only one of the Parts. and that on which you shall fix one of your Eyes more intently than the other: Hence we may, with *Gassendus*, assure the Gunners that they shall shoot as right with both Eyes open as only with one: Thus in confus'd and imperfect Vision; tho' it may be truly said, a Man doth see with both Eyes at once, but not distinct and perfect, there being several Degrees of Vision.

81. *That the Matter of a Body, when rarefy'd, doth possess no more of true Place than the Matter of the same Body condensed.*

Answer. When a Fleece of Wool is distended, we say 'tis made more rare, and when compress'd more dense; now the Rarefaction consists in this, that the Hairs formerly united are disunited, and the Spaces betwixt them become larger, in which no Particle of Wool is contain'd, and Density is quite the contrary; now tho' a Fleece of Wool expanded includes a greater Capacity therein than when

compress, yet the single Hairs thereof take no greater Space in either Capacity; for no Hair can possess more Space than its proper Bulk requires, but the empty airy Spaces intercepted, are enlarged in the Rarefaction and diminished in the Compression: Hence 'tis true, that the Matter of a Body rarefy'd, *i. e.* the sundry indefinite Particles possess no more of true or proper Place than the Matter of the same Body condensed, though the Surface of the same Body may possess more Place, when rarefy'd than when condensed, because then, it not only takes in the Particles of Space occupied by the Particles of Matter rarefy'd, but also all the enlarg'd Vacuities interspersed.

82. *A certain Traveller, of unquestionable Integrity relates, he, in the East Indies, saw Sun, Moon and Stars all at once, at Noon-day: Yea, and in the Reign of Tiberius, the Sun was seen to set at Noon, when it was Full-Moon; and tho' there was Darknes above the Earth, yet was there Light under it, nay, that very Darknes became a Light, and in a few Days two real Suns, not mock ones, arose in one Day, within a few Hours of each other.*

Answer. This consists of several Parts. as to the first, Father Kircher, in his Description of the Subterraneous World, Lib. 2. tells us, that by the Help of a Telescope we may perceive the Sun, a Body of Fire unequal in its Surface, compos'd of several Parts of a different Nature; some fluid, some solid, and that his Disk is a Sea of Fire, wherein one may perceive an eternal Agitation of the Waves of
Flame.

Flame, that in some Parts of it there arises a deal of Smoke: Now 'tis very probable, that a vast Quantity of Smoke might intercept and hinder the Brightness of the Sun; as in 1547, from the 4th to the 28th of August, the Sun appear'd reddish, and not so bright as the Moon in her total Eclipse, so that then there were many Stars visible at Noon, Day, which being as bright as at other Times, plainly show, the fix'd Stars receive not their Light from the Sun, but are rather so many Suns themselves, at an indefinite Distance.

As to the latter Part of the Paradox, because the Reign of Tiberius is mention'd, probably that preternatural Darkness which happen'd at our Saviour's Crucifixion, which was then Full-Moon, is meant, and the Darkness began at Noon, or 6th Jewish Hour, and continued to the 9th, which miraculous Darkness also, proved a Light to Dionysius the Areopagite, of whom it is reported, that beholding it, he said, *Either the World is at an End, or the God of Nature suffers*; and in a few Days, i. e. on the third Day early in the Morning, before Sun-rise, arose the very Sun of Righteousness, who was, and is, *The true Light that enlightens every Man coming into the World*; according to John 1. 9.

83. *There are several Places on the Continent of EUROPE, where, at some certain Seasons of the Year, if a Feather and Globe of Lead were let fall exactly together, the Feather will reach the Bottom as soon as the Lead; which Places, then, are of such detestable Quality, that if a Sparrow, never so lively, should chance to fly over it, would immediately fall down in a Swoon, which upon breath-*

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ing on, in the Turn of an Hand, will revive and be as brisk as ever.

Answer. In any Place where the Air-Pump is, and at any Season when the Receiver is exhausted of the Air within, such strange Effects will happen: and by *breathing upon, in the Turn of an Hand*, is intended the Re-admission of the Air, whereby the Sparrow will revive again.

84. *On the Continent of ASIA, there is a certain Country, some of whose Inhabitants, though they live, not many Hours, yet they breed and bear without Food or Care, and their Generations have continued many Ages, where also the very Desert affords them vegetable Springs of Water.*

Answer. *Neuette* tells us of a Tree called the *Bejuco*, which twisting about other Trees, with its End hanging downwards, and that Travellers cut the Nib off it, and presently a Spout of Water runs out from it as clear as Chrystal, enough and to spare for six or eight Men. I drank (saith he) to my Satisfaction, of it, and found it cool and sweet, and would drink it as oft as I found it in my Way; it is a *Fuice* and natural Water. 'Tis the common Relief of the Herdsmen on the Mountains, when they are thirsty they lay hold on the *Bejuco* and drink their Fill. Collect. of Voyag. Vol. I. pag. 355. this then is a delectable vegetable Spring of Water. Also, if an Insect may be term'd an Inhabitant, *Swammerdam* mentions the *Ephemeron*, which is both an unusual and special Instance of the Brevity of Life, and a wonderful Instance of the special Care and Providence of GOD in the Conservation of the Species of that Animal: For,

1st. As an Animal, whose Life is determined in about five or six Hours, it needs no Food. 2^d. As to its Generation, in those five Hours of its Life it performs that and other necessary Offices of Life; for in the Beginning of its Life it sheds its Coat, and that being done, and the poor little Animal thereby rendered light and agil, it spends the rest of its short Time in frisking over the Waters, and, at the same Time, the Female droppeth her Eggs on the Waters, and the Male his Sperm on them, to impregnate them; these Eggs are spread about by the Waters, and descend to the Bottom by their own Gravity, and are hatch'd, by the Warmth of the Sun, into little Worms, which make themselves Cases of the Clay and feed on the same, without any Need of Parental Care.

85. 'Tis as demonstrable as wonderful, that Mathematicians may draw Lines both strait and circular, which shall always approach nearer and nearer to a given Line, even unto Infinity; but either will never be joyn'd to it, or if joyn'd will never unite or meet, save in one single Point; and tho' the Angles formed at the said Point may be diminished by Arches, yet cannot so much as be bisected by any right Line whatever; and said Angles are both greater, equal and less than a right Angle.

Answer. The Corollaries of the 16th Proposition of third Book of *Whiston's Euclid*, aforesaid will illustrate this Paradox; to which I refer, when I have told my Reader that this Paradox means, not only the Angle of Contact, but the Approach of the Asymptotes to an Hyperbola, both infinitely produced unto a Distance, less than any given one, yet

never concurring with it: By this Proposition, is plainly interr'd the infinite Divisibility of Matter, Lines and Points.

86. *There is a certain Island in the Continent of EUROPE, some of whose Inhabitants are of such exquisite Sight, that even with one of their Eyes, they can actually behold ten Moons, real and True, all at once, above their Horizon, yea, and ten Times the Number of Stars beheld by others with both their Eyes at the same Instant: Yea, such wonderful Properties have these single-sighted few, that in Things small and near, which escape the Sight of their Neighbours, they behold new Worlds of Wonder, see all the distinct Parts and Functions of those minute Animals: Nay, like Cats, they can see in the Dark, and in an Instant, and in the Dark also, draw, to the Life, and paint in lively Colours, far beyond Michael Angelo, or any other, in the best Light and longest Time. Lastly, such dextrous Hands have they, that in the Turn of an Hand they can command the Sun, Moon and Planets to rise and set and perform their diurnal Revolutions and their annual ones in a few Minutes, and predict their mutual Eclipses for many Years to come.*

Answer. Any Island; any where, provided there be Mathematicians furnish'd with exquisite Telescopes, which will show the five Satellites or Moons of Saturn, the four Moons of Jupiter, and our Moon.

all

all which are ten in Number, such will see through them ten Stars for one beheld by our Eyes not assisted with the like; nay, in the milky Way, where we can't behold one, they will see an innumerable Company so close and thick set, that their united faint Light cause that Whiteness which gives it the Denomination aforesaid. The *Middle Part* of the *Paradox* respects the Wonders of the Microscope, and the next intends the admirable and instantaneous Painting to the Life, perform'd by the *Obscura Camera* (or dark Room) of the Philosophers; and the *Last* means the noble and useful Invention of the *Orrery*, which shows, by one Turn of the Hand, the visible Revolution of the *Earth, Moon, Venus and Mercury*, their Mutual Aspects, Eclipses, &c. for any Time past, present or to come.

The Periodical Revolution of the Moons of Saturn and Jupiter

		D. H. M. S.			D. H. M. S.
1	} next Saturn.	1 21 18 31	} next Jupiter	}	1 18 28 00
2		2 17 41 27			3 13 14 00
3		4 13 47 16			7 3 43 00
4		15 22 41 11			16 16 32 00
5		79 7 53 57			

87. *There is a certain Island in EUROPE, for which, in four or five certain Months of the Year, if the ablest Astronomers the World has, would calculate the Moon's Rising, they would not only differ in Minutes and Seconds, but whole Hours; and from which if they take a Journey in one Part, their Shadows will disappear; in another they will circuit all Parts of the Compass.*

Answer

Answer. This may respect the Variety of Risings of the Planets and Stars, as to one the Cosmical, the other the Acronical, the third the Heliacal, the fourth the true or apparent Diurnal Rising of the Moon: Each Astronomer, tho' exactly true, respecting that particular Rising, will differ from the rest, not only in Minutes and Seconds, but Hours and Days: The latter Part of the *Paradox* respects the Diversity of Shadows; under the Poles or Polar Circles the Shadows move all round about, under the Tropics no Shadow at all when the Sun is in the Zenith; but in the North Temperate, our Noon Shadow is always North, and in the South Temperate, always South.

88. *To several Parts of this Globe, there be certain Planets, which are so far from coming to an Opposition, that they form neither Trine, Square nor Sextile Aspect with the Sun: and there be other Places, where, if you bring a Mariners Compass, though never so well touched and rectified, the Needle is of no Service, because it will turn indifferently, to any Point of the Compass, tho' neither Iron nor Loadstone be near.*

Answer. Venus and Mercury, whose Orbits are contain'd within the Orbits of the Earth, never form so much as a Sextile Aspect with the Sun: And in or near the two Poles of the Earth, the best Needle turns indifferently to any Point of the Compass.

89. *There be several Planets or wandering Stars, which at certain Times, appear and disappear, whose Light decreases as they come towards*

towards the Earth, and increases as they go from the Earth; yea, so transparent are they, that the smallest Stars may be seen through them: Yea, and there be others so opaque, that in Conjunction with the Sun, they appear as spots in his Face, and the further they go from us the bigger they appear.

Answer. The first Part respects Comets which wander through all the Orbits of the fixed Stars, and do decrease in Light as they come towards the Earth, and increase as they go from it; through whose Tails the fixed Stars of the 6th Magnitude may be seen: The other opaque Planets, which appear as Spots now and then in the Sun's Face, are *Venus*, *Mercury*, and the *Moon*, which appears bigger in the Horizon when further from us, than in the Meridian when she is above three thousand Miles nearer us, as in *Paradox 19*. The Cause of which *Phænomenon* some attribute to the Refraction, others to the Picture in the Bottom of the Eye, others to the Judgment in great Distances, says *Gravesand*, Vol. 2. N. 731. "If we look at known Objects we judge from the apparent Magnitude and Colour which depends upon the Bigness of the Picture in the Bottom of the Eye, and this on the Angle under which the Object is seen."

Now 'tis well known to Astronomers, the Picture of the Sun in the Bottom of the Eye, is the same in both Cases, and that of the Moon is less when it appears near the Horizon, because she is farther off by a Semidiameter of the Earth, which bears some Proportion to her Distance from the Earth, though little with respect to the Sun's Distance from us, yet they appear greater near the Horizon by reason of the Interposition of the Fields and Houses betwixt us and that Part of the Heavens

Heavens: Also they appear nearer to us, and of a different Colour, because of the Dimness, Grossness and Density of the lower Atmosphere, the Body of the Air is twelve times greater near the Horizon than near the Zenith, thro' which the Rays of the Sun pass; this not only magnifies the Refraction, but so dims its bright Rays, that without hurting the Eyes we can look upon him Rising or Setting; but not so when on the Meridian near the Zenith, because its Rays hitting against an infinite Number of Particles in the Air, near the Horizon are reflected or absorb'd.

Howbeit, if we see the Bodies above-mentioned thro' a Tube, this apparent Distance vanishes, as also the Magnitude which is deduced from it: From our Childhood upwards, and so continually, we join the Idea of Distance with the Increase of Apparent Magnitude, whereby the Idea's are so closely joined that they cannot be separated, not even in those Cases in which we know they lead us into Error.

Moreover, Refraction causes the horizontal Sun and Moon to appear of an oval Figure; for their inferior Limbs are more refracted and rais'd higher than their superior Limbs are; and therefore these two Limbs will seem nearer to each other, while the Ends of the horizontal Diameter being equally refracted, keep the same Distance.

The French observed, that an Object which at Break of Day appeared in our Horizon or level Line, or a little above it, a little after Sun-Rise, appear'd below it; and the same Appearance they found in the Evening; for the Object before Sun-Set appeared below the Level, which soon after Sun-Set would appear in it. in so much that in about half an Hour's Time the Difference has been observed to be no less than three Minutes, the Cold of the Night condensing the Vapours, making them of different Density, causes the Refraction aforesaid. Nay, three Points which appear at one Time in a straight Line,

ine, have at another Time, within half an Hour, appear'd out of it considerably. Hence, even the light it self that is the Ray of Light, passing from Point to Point thro' the Air, is not a strait Line, as to its Position. by reason of the different Refraction which is in the Medium of the Air.

90. *There be many Places of the Earth, to whose Inhabitants the Sun and above twice seven Planets, may be all visible in one certain Night of the Year; and one of the said Planets, tho' it ever changes, yet still, to them, turns always the same Face.*

Answer. The five Moons of Saturn, the four Moons of Jupiter and our Moon, which make ten Moons, besides the usual Planets Venus and Mercury, which are inferior, and Saturn Jupiter and Mars, which are the superior Planets, besides the Earth. Howbeit all these Moons are visible only in those Places where are extraordinary Telescopes, and only in those Nights when they are out of the Shade of their primary Planets, about which they roll. 2^{dly}, Our Moon, tho' ever changing, as to her Phases continually increasing or decreasing in Light; yet because her periodical Revolution, about her Orbit and Axis, is perform'd exactly in the same Space of Time; therefore the Moon's Axis keeps its Parallelism, and still obverts the same Hemisphere or Face to the Earth, which, as to its Illumination and Obscuration, is continually changing, according to its Recess from and Access to the Sun.

91. *There is a certain Fire which burns at a Distance, and yet those that are several Yards nearer and between, are not so much as warm'd*

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warm'd by it; nay, its Heat is greater the further it is from us, and the less the nearer it is to us.

¶

Answer. This must be the Sun, which appears like a burning Ocean, whose Beams scorch and burn near the Earth, at the Foot of a Mountain; yet on the Top of *Pico Teneriff*, which is many Yards nearer to it, the Sun's Reflection scarce reaches or warms; where the cold Air continually changes for fresh. Moreover, the Sun's Heat, every Body knows, is greatest in *Summer*, when he is furthest from us, and least in *Winter* when he is nearest to us; for the Degrees of Heat and Cold do not altogether depend upon our Distance from the Sun, the Difference of which Distance is but small, and bears little Proportion to the Sun's Distance from us; but there are other powerful concurring Causes which have certain Effects. For first of all, the direct Force of the Sun's Rays, is much stronger than when they are receiv'd obliquely; because there are much fewer Rays in the same Space, when the Rays fall obliquely than direct: Besides in *Winter*, when the Sun is nearest to us, as aforesaid, his Rays or Beams pass through a much greater Quantity of Air, and are deeper immers'd in our Atmosphere than they are in *Summer* when the Sun is furthest off us. Again, in *Summer* we have sixteen Hours Sun-shine, and but eight Hours Night, but in the *Winter* the quite contrary; therefore no Wonder that the longer any hard Body is expos'd to the Fire the hotter it still grows; for the Action of the Sun, by which all Bodies are heated, is not transient, as its Illumination is, but permanent: For this Cause, 'tis hotter under the Tropics than the *Æquator* it self; because the Days are longer by an Hour an half there than under the Line, from whose Zenith the Sun recedes three Degrees in three Weeks Time; but is about
two

is about two or three Months going so far from the Zenith under the Tropics.

92. *There is one certain Place of the World where the Planets, both Inferior and Superior, may be beheld constantly to move forward, in the same regular and uniform Tenor; tho' to most Places of the Earth they appear at the same Time to be stationary, Retrograde, or to move very unequally.*

Answer. At the Sun, the true Center of the World's System, the Planets move all regular and direct; tho' to us, out of the Center of their Orbits, they appear sometimes Direct, sometimes Retrograde, and sometimes Stationary.

93. *Of all the Stars in a Star-light Night, tho' their Numbers seem near infinite, and FLAMSTEED has given a Catalogue of three thousand, yet it will be hard for a piercing Eye to reckon, at any Time above an hundred; notwithstanding in a clear Winter's Night, without Moon shine, at first View they seem to be innumerable.*

Answer. This Appearance is only a Deception of our Sight, arising from their vehement and strong Twinkling, while we look upon them confusedly and without reducing them to any Order; yet that in Reality their Number is next to infinite, appears from the Discoveries the Telescope has made; for Dr. Hook, with only his twelve Foot Telescope, numbers seventy eight Stars in the Compass of the Pleiades, where only six appear to the

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naked Eye; and *Anton. Maria de Roita*, affirms, he has numbred, in the single Constellation of ORION, two thousand.

94. *Notwithstanding the diurnal Motion of the Earth about its Axis, and the annual Motion of the same about its Orbit, yet have sundry Astronomers attributed a third Motion to the Earth, i. e. that whereby the Parallelism of its Axis is maintain'd, which others affirm is no Motion.*

Answer. The Parallelism of the Earth, or that constant Position of the Earth's *Axis*, which, in every Point of its Orbit, is parallel to it self in any other Point; which never changes its Direction, but always looks to the same Point of the Heavens, doth necessarily follow; if the Earth hath no other Motion but that round the Sun and the other round its own Axis. For tho' all the Diameters of the Earth will constantly change their Position by this Rotation about its *Axis*, except the *Axis* alone, which will remain at Rest (like the Center in a Circle) in its former State, the Points in the *Axis* being the only Points in the Body which have no Rotation.

95. *There are several Planets said to be in Conjunction with the Sun, not only when they appear in the same Degree of their Orbit with the Sun, but when they are in that Degree of their Orbit diametrically opposite to the former.*

Answer,

Answer. The several Planets are *Venus* and *Mercury*, who have a two-fold Conjunction with the Sun, both in the superior and inferior or opposite Points of their Orbits; in the first they are like Spots between the Sun and us, and in the last the Sun is between us and them.

96. *There are sundry Places of the World, when coldest much hotter than any Part of the Torrid Zone, and yet no burning Mountain; and other Places, when hottest much colder than our Frigid Zone.*

Answer. The first must be in *Venus* or *Mercury*, and the last must be in *Saturn* or *Jupiter*.

97. *What Seas have their Waters fresh, and no Tide neither ebbs nor flows? And what Straits and Springs have their Waters salt? and the Reasons why.*

Answer. The *Dead Sea*, the *Euxine* and *Baltic* Seas have fresh Water and no Tide; and the Streights of *Davis*, *Hudson* and *Frobisher* are salt, because the *Baltic* Sea has many Islands at the Mouth of it, that it takes not in that Quantity of Water from the main Ocean, but receives more from the many fresh Water Rivers which discharge themselves into it from *POLAND*, *RUSSIA* and *SWEDEN*; the like concerning the *Euxine*. And in *Burgundy* and *Lorain* there are Springs which send forth salt Water; because they dissolve the Salt, which they meet with in the Earth as they run along.

98. *What is the Reason of the Cohesion of two well polish'd Glasses or Marbles together so hard that three Quarters of an Hundred Weight, fastened to the lower, will not separate it from the upper one?*

Answer. Doubtless the Pressure of the Atmosphere, which pressing hard upon the obverted Planes of the Glass or Marble; and there being no Air between, to resist the external Pressure, there must necessarily follow the Cohesion aforesaid. For in an unexhausted Receiver one Pound Weight sufficed to part two such Marbles, that no less than eighty Pound Weight, in an open Air could separate them. This Experiment of the famous BOYL, confirms the Pressure of the Atmosphere, and the above Solution.

99. *'Tis reported by the Duke of Genoa, that a Ship was found in Switzerland with the Bodies of forty Men in it: Also another Ship, in the Bottom of a Lake in Italy, which last was supposed to be ever since the Reign of Tiberius: How got they there?*

Answer. That the first could not be from Noah's Time, because Navigation, especially on the Ocean, was not grown to such a Perfection in his Time as to make Ships of that Bigness and Anchors of that Perfection. 2dly, If such Ships had been, it might probably happen that some other Men or Creatures might have escaped with Life, besides those in the Ark. 3dly, How could a Ship, of that Bigness, be carried six hundred Feet under Ground? certainly
twelve

twelve Months, much less forty Days, Rain could not reduce the Land to such a Quagmire.

Next, A subterraneous Navigation seems a ridiculous Supposition; wherefore, for assigning a Cause sufficient, I conceive, there cannot be a more probable one than the Effect of Earthquakes. Suppose then that Part of *Switzerland* was the Bottom of the Sea, when this Vessel was directly over this Place, and an Earthquake happen'd just underneath, which did raise the same above the Level of the Water as much as 'tis now, and closing the Gap, inclosed both Water, Ship, and Men, which it had swallowed.

100. *That there is another more powerful Cause of the Twilight than the Reflection of the Earth's Atmosphere.*

Answer. There is an *Æthereal Air* or Atmosphere round about the Sun, which shines after the Sun's Body is set, this Orb of the Sun's Atmosphere rising sooner and setting later than the Sun is self, shines out at Mornings and Nights in a circular Figure, it being a Segment of the Sun's Atmosphere, cut by the Horizon. and its Light is quite of another Sort than that which is made by the Reflection of our Atmosphere, but its Duration is much shorter.

P. Nonnius to find the Length of the Twilight, watch'd the Time after Sun-Set, when the Twilight in the *West* was shut in, so that no more Light appear'd there than in any other Part of the Sky near the Horizon: Then, by one of the known fixed Stars having taken the true Hour of the Night, found, by several Nights Observation, that at the Time of shutting in the Twilight, the Sun was under the Horizon eighteen Degrees; and until the Sun was depress'd so low, the Twilight continued.

The Sun being in the *Winter Tropic* maketh the longest *Twilight*, and from thence, as the Days increase the *Twilight* decreases until it comes to the shortest, which is in a certain *Parallel* between the *Tropic* and *Equinoctial*, the *Declination* whereof is found by this Proportion: As *Co-tangent* of the *Latitude* to the *Sine* of the *Latitude*, so is the *Tangent* of nine Degrees to the *Sine* of the *Declination* of the said *Parallel*. But before the *Crepusculum* or *Twilight* comes to be the shortest, there is another *Parallel*, in which the *Crepusculum* is equal to the *Crepusculum* of the *Equinoctial*, which is found by this Proportion: As *Radius* to the *Sine* of the *Latitude*, so is the *Sine* of eighteen Degrees to the *Sine* of the *Declination* of the *Parallel* sought.



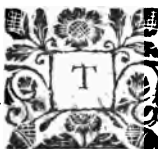


P A R T I I I .

A N

APPENDIX.

Containing ANSWERS to the
Hundred *Arithmetical Problems* left un-
answered in HILL's *Arithmetick* and
ALEXANDER's *Algebra*.

- I.  Find a Number which be-
ing multiply'd by 3, subtract-
ing 5 from the Product, and
the Remainder divided by 2,
if the Number sought be ad-
ded to the Quotient, that the Sum may be 40.

Answer. The Number is 17.

2. To find a Number, which being multiplied by 12, and 48 added to the Product, as much may be produced, as if the same Number sought were multiplied by 18.

Answer. The Number is 8.

3. To find a Number, to which if 11 be added and 7 subtracted from the same Number (viz. the first) the Sum of the Addition may be double the Remainder.

Answer. The Number is = 25.

4. To find a Number, to which if its double (triple, quadruple, &c.) be added, the Square of the same Number may be produced.

Answer. Let b = multiple, then the Number = $b + 1$.

5. To find a Number, which if added to it self, and the Sum multiplied by the same; and the same Number still subtracted from the Product: And lastly, the Remainder divided by the same, that it may produce 13.

Answer. The Number is 7.

6. To divide the Number 16 into 2 Parts, so that the Square of the greater Part may exceed the Square of the less by 32.

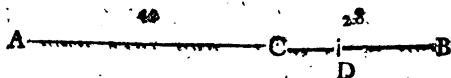
Answer. The Numbers are 9 and 7.

7. To

7. To divide the Number 36 into 2 Parts, so that if 12 be added to the first. and 6 to the second, the former may be the Double of the latter.

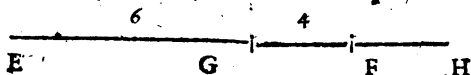
Answer. The Numbers are 24 and 12.

8. Let the Line AB (of 70 Parts) be divided any how in C (so that AC may be 42, BC 28) it is required to divide the same Line again in another Point: For Example, in D , so that the Rectangle ADC may be equal to the Square DB . Let the Segment CD be enquir'd (which being obtain'd AD , DB will be known.)



Answer. The Segment CD required is = 8.

9. Let the Line EF be divided any how in G (so that EG may be 6, GF 4) it is required to produce this right Line EF (for Example unto H) so that the Rectangle EHF may be equal to the Square GH ; the Length of FH is required.



Answer

82 *Arithmetical Problems solv'd.*

Answer. The Length of FH sought is = 8.

10. *A General disposing his Army into a Square Battle, finds he has 284 Soldiers over and above; but increasing each Side with one Soldier, he wants 25 Soldiers to fill up the Square: How many Soldiers had he?*

Answer. He had 24000.

11. *A certain Captain sends out $\frac{2}{3}$ of his Soldiers + 10; there remains $\frac{2}{3}$ + 15. How many Soldiers had he?*

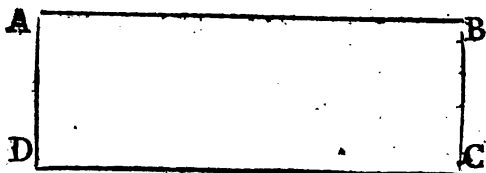
Answer. He had 150.

12. *There is an Army to which if you add $\frac{1}{4}$, $\frac{2}{3}$ and $\frac{1}{2}$ of itself, and take away 5000, the Sum total will be 100000. What was the Number of the Army?*

Answer. The Number was 60000.

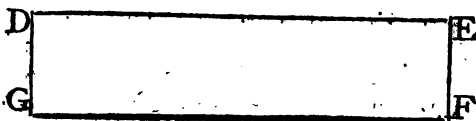
13. *In the Rectangular ABCD, the Difference of the greater Side AB, and of the lesser Side BC is 12; but the Difference of the Squares of the Sides 1680. What are the Sides of the Rectangle ABCD?*

Answer.



Answer. Length = 76, and Breadth = 64.

14. *The Length DE of the Rectangle DEFG, is twice the Breadth EF; and the Sum of the Squares of the Length and Breadth is ten times the Sum of the two Sides DE, EF. What are the Sides of the Rectangle DEFG?*



Answer. The Sides 6 and 12.

15. *To find two Numbers in the Proportion of 2 to 3, whose Product, if they be multiplied by one another shall be 54.*

Answer. The Numbers are 9 and 6.

16. *To*

84 *Arithmetical Problems solv'd.*

16. To find two Numbers whose Ratio is to one another as 4 to 5; and the Sum of the Squares of both is 2624.

Answer. The Numbers are 40 and 32.

17. To find the side of a Square, whose Area is to the sum of the sides in a given Ratio, as 45 to 12.

Answer. The Side is 15.

18. To find the side of a Cube, whose Superficies is to the Solidity in a given Ratio, as 6 to 11.

Answer. The Side is 11.

19. A certain Man hires a Labourer, on this Condition, that for every Day he work'd he should receive 12 Pence, but for every Day he was idle he should be mulct'd 8 Pence. When 390 Days were past, neither of them were indebted to one another. How many Days did he work, and how many was he idle?

Answer. He wrought 156 Days, and was idle 234.

20. A certain Gentleman hires a Servant, and promises him 24 Pounds yearly Wages, together

together with a Cloak. At 8 Months End the Servant obtains Leave to go away, and instead of his Wages receives a Cloak + 13 Pounds. How much did the Cloak cost?

Answer. It cost nine Pounds.

21. A Person being asked how old he was, answered, If I quadruple $\frac{2}{3}$ of my Years, and add $\frac{1}{2}$ of them + 50 to the Product; the sum will be so much above 100, as the Number of my Years is now below 100.

Answer. His Age was 36 Years.

22. One being asked what Hour of the Day it was, answer'd, The Day at this Time is 16 Hours long; if now $\frac{1}{2}$ of the Hours past be added to $\frac{2}{3}$ of the Remainder, you will have the Hour desired, reckoning from Sun-Rising.

Answer. The Time from Sun-Rising is $9\frac{3}{4}$ and consequently the Time of Day was $1\frac{1}{4}$.

23. From Norimberg to Rome are 140 Miles: A Traveller sets out at the same Time from each of the two Cities, one goes 8 Miles a Day, the other 6. In how many Days from their first setting out will they meet one another, and how many Miles did each of them go?

Answer. They'll meet in 10 Days, when the one has gone 80 and the other 60.

24. *A certain Messenger goes 6 Miles every Day: 8 Days after, another follows him, and he goes 10 Miles a Day. In what Number of Days will he come up to the first.*

Answer. In 12 Days.

25. *A certain Messenger goes 6 Miles a Day; and after he has gone 56 Miles, another follows him who goes 8 Miles a Day. In how many Days will he come up to him?*

Answer. In 28 Days.

26. *One bought 3 Books, whose Prices were in Proportion as 12, 5, 1: If the Price of the first be doubled, of the second tripled, of the third quadrupled; the Sum of these Products will as much exceed 10 Crowns, as the Sum of the Prices of the greatest and middle is below 5. How much did the said Books cost?*

Answer. The first cost 3, the Second $1\frac{1}{5}$, and the third $\frac{1}{5}$.

27. *Suppose the Number 50 were to be divided into two Parts, so that the greater Part being divided by 7, and the less multiply'd by 3, the sum of this Product and the former Quotient, may make the same Number proposed, which was 50.*

Answer

Answer. The Parts are 35 and 85.

28. Let the Number 20 be divided into two Parts, ~~that~~ that the square of the less Part being taken out of the square of the greater, may leave the very Number proposed, which was 20 (or may leave the double, triple, &c of the Number propos'd)

Answer. The Parts are 10.5 and 9.5.

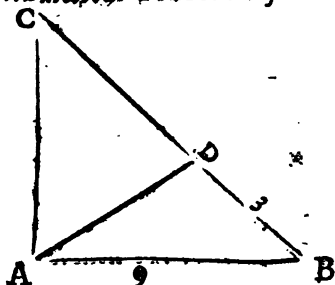
29. If a Man gains 30 Crowns a Week how much must he spend a Week to have 500 Crowns, together with the Expence of 4 Weeks remaining at the Year's End?

Answer. 18.92857.

30. A Labourer, after 40 Weeks in which he had been at Work, lays up 28 Crowns — the Pay of three Weeks; and finds that he had expended 36 Crowns + the Pay of eleven Weeks. What Pay did he receive a Week?

Answer. He received two Crowns per Week.

31. In the Rectangle-Triangle ABC, is given the Basis $AB=9$ and the Difference of the other sides, that is the Segment $BD=3$. Required the sides AC, BC.



Answer. The Sides are 12 and 15.

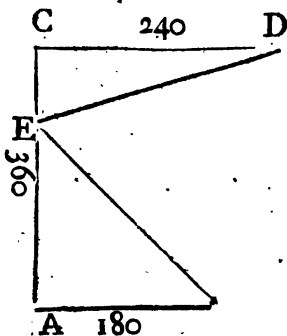
32. In the *Rectangle-Triangle ABC*, is given the Basis $AB=5$, and the Sum of the other sides $AC + BC = 25$. Required the Sides AC , BC severally.



Answer

Answer. The Sides are 13 and 12.

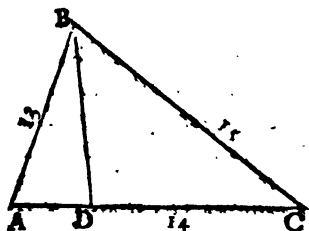
33. Suppose two Towers, AB 180 Feet high, and CD 240, at the Distance AC 360 Feet. A Ladder is to be set upon the Line AC , at some Point, suppose in E , of such a Length, as from thence it may reach the Top of both the Towers. We require the Point E in the Line of Distance, as also the Length of the Ladder EB , ED .



Answer. CE is $= 145$, AE is $= 215$, $BE = ED = 280.44$.

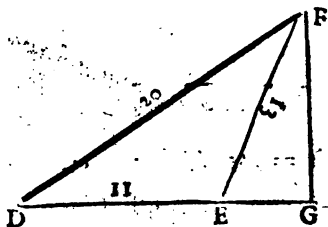
34. In the Triangle ABC , the several sides $AB = 13$, $AC = 14$, $BC = 15$ are given; and the Perpendicular BD being drawn. Required the Segment of the Basis, AD , DC .

Answer.



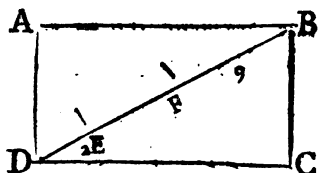
Answer. AD is = 5, and DC is = 9.

35. In the obtusangle-Triangle DEF, the several sides are given, viz. DE 11, EF 13, DF 20; and the Perpendicular FG being let fall upon the Basis produced. Required the Prolongation of the Basis EG.



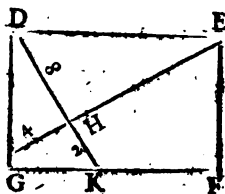
Answer. EG is = 5

36. In the Rectangle $ABCD$, is given the Difference between the Length AB and the Diagonal BD , that is $DE = 2$; and likewise the Difference between the Breadth AD and the Diagonal BD , that is, $FB = 9$. Required the Sides of the Rectangle AB , AD ?



Answer. AB is $= 15$, and AD is $= 8$.

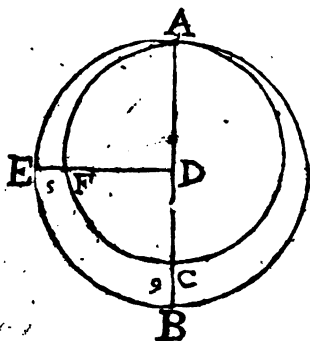
37. In a Rectangle $DEFG$, the right Line DK is drawn from the Angle D to the opposite Side, cutting the Diagonal EG at right Angles in H : And there is given the Segment $HK = 2$, and $HE = 16$. Required the Sides of the Rectangle?



Answer. DE is $= 17.333$, and GD is $= 3.944$.

38. Let

38. Let there be a Circle, whose Diameter is AB , with another less Circle whose Diameter which is AC , touches within in A : And from the Center of the greater Circle D , draw the Radius DE at right Angles to AB , cutting the Periphery of the lesser Circle in F . Now there is given BC (the Difference of the Diameters) $= 9$, with the Segment $EF = 5$. Required the Diameters AB , AC of the said Circles?



$$(x-5)^2 = x(x-9)$$

Answer. AB is $= 50$, and AC is $= 41$.

39. Two Companions have got a Parcel of Guineas; says A to B , if you will give me one of your Guineas I shall have as many as you will have left. Nay, replies B , if you will give me one of your Guineas, I shall have twice as many as you will have left. How many Guineas had each of them?

Answer.

Answer. A had 5 and B 7.

40. A certain Person bought two Horses, with the Trappings, which cost 100 Pounds; which Trappings if laid on the first Horse A, both the Horses will be of equal Value: But if the said Trappings be laid on the other Horse, he will be double the Value of the first. How much did the said Horses cost.

Answer. The first cost 200 and the second 300.

41. A Vintner has two sorts of Wine, viz. A and B; which if mix'd in equal Parts, a Flaggon of mix'd will cost 15 Pence; but if they be mix'd in a sesqui-alter Proportion, as if you should take 2 Flaggons of A as often as you take 3 of B, a Flaggon will cost 14 Pence. Required the Price of each Wine singly?

Answer. A Flaggon of A is worth 20d. and of B 10d.

42. A Son asked his Father how old he was; his Father answered him thus, If you take away 5 from my Years, and divide the Remainder by 8, the Quotient will be $\frac{1}{2}$ of your Age: But if you add 2 to your Age, and multiply the whole by 3. and then subtract 7 from the Product, you will have the Number

94 *Arithmetical Problems solv'd.*

ber of the Years of my Age. What was the Age of the Father and the Son?

Answer. The Father 53 and the Son 18.

43. *To find out two Numbers, to the Sum whereof if you add 6, the whole shall be double the greater; and if you subtract 2 from their Difference, the Remainder will be half of the least.*

Answer. The Numbers are 14 and 8.

44. *To find two Numbers, the Product whereof is 240, and the Triple of the greater divided by the less is 5.*

Answer. The Numbers are 20 and 12.

45. *Two Men have a Mind to purchase a House rated at 1200 Pounds; says A to B, if you give me $\frac{2}{3}$ of your Money, I can purchase the House alone; but says B to A if you will give me $\frac{1}{2}$ of yours, I shall be able to purchase the House. How much Money had each of them?*

Answer. A had 800*l.* and B 600*l.*

46. *Some young Men and Maids had a Reckoning of 37 Crowns to pay for a Treat, and this was their Conditions, that every young*

young Man should pay 3 Crowns, and every Maid 2. Now, if there had been as many young Men as there were Maids, observing the same Conditions, the Reckoning would have come to 4 Crowns less than it did. How many young Men and Maids were there?

Answer. There were $7\frac{1}{2}$ Men, and $6\frac{1}{2}$ Maids.

47. A General who had fought a Battle, upon reviewing his Army, whose Foot was thrice the Number of his Horse, finds that before the Battle $\frac{1}{2}$ — 120 of his Foot had deserted, and of his Horse $\frac{2}{5}$ + 120, besides $\frac{1}{4}$ of his whole Army were sent into Garrisons (reckoning the sick and wounded) and $\frac{1}{8}$ of his Army remain'd; the rest, who were wanting, being either slain or taken Prisoners; now if you add 3000 to the Number of the slain, the Sum will be equal to half the Foot he had at the Beginning. What were the Numbers of each?

Answer. 30000 Foot and 10000 Horse.

48. To divide 100 twice into two Parts, so that the major Part of the first Division may be triple the minor Part of the second Division; and the major Part of the second may be double the minor Part of the first.

Answer. The Parts are 60, 40, and 80, 20.

49. To

49. To divide 30 twice into two Parts, so that the major Part of the first Division, with the minor of the second may be 33; and the Sum of the minor Parts subtracted from the Sum of the major, may leave 14 remaining.

Answer. The Parts are 20, 10, and 17, 13.

50. A Man, his Wife, and his Son's Ages make up 96 Years, so that the Husband's and Son's Years together make the Wife's + 15; but the Wife's and the Son's make the Husband's + 2. What was the Age of each?

Answer. The Husband 47 Years, the Wife 40 $\frac{1}{2}$ and the Son 8 $\frac{1}{2}$.

51. Three Merchants from three different Fairs meet together at an Inn, where they reckon up their Gains, and find them the Sum of 780 Crowns. Moreover, if you add the Gain of the first and second, and subtract the Gain of the third from the Sum, there remains the Gain of the first + 82 Crowns; but if you add the Gain of the second and third, and from the Sum subtract the Gain of the first, there remains the Gain of the third - 43 Crowns. What was the Gain of each?

Answer. The Gains were 316, 273 and 191 Pounds

52. Three

52. Three Persons, *A*, *B*, *C*, owe a certain Sum of Money, so that *A* and *B* together owe 210 Crowns; *B* and *C* 290, and *A* and *C* 400. What did each of them owe?

Answer. *A* owed 160. *B* 50, and *C* 240.

53. To find three Numbers, so that the first and half of the Remainder, the second and $\frac{1}{2}$ of the Remainder, and the third and $\frac{1}{4}$ of the Remainder, may always make 34.

Answer. The Numbers are 10, 22 and 26.

54. Let a Square be divided into 9 small Squares: We are to find and dispose the Numbers through the several small Areas, so that the Sum of every three, taken either laterally or diagonally may be always 15.

Answer.

2	9	4
7	5	3
6	1	8

55. (Theorem) Let any Numbers whatsoever be given, if you subtract every less Number from that which is the next greatest: I say, that the Sum of those Differences is equal to the Difference of the greatest and least Numbers.

I

56. To

98 *Arithmetical Problems solv'd.*

56. To find a Number, which being multiplied by 6, and the Product subtracted from the Square of the Number to be found, the Remainder will be 280.

Answer. The Number is 20.

57. To find a Number which being multiplied by 8, and the Product added to the Square of the Number to be found, the Sum will be 660.

Answer. The Number is 22.

58. To divide 140 into two Parts, so that the Product of those Parts may = the Square of 56, that is 3136.

Answer. The Parts are 112 and 28.

59. Let 969 Soldiers be drawn up into an oblong Battle, so that the Difference of the greater and less Sides is 40. Required the Number of the Soldiers in each Rank, in Length and Breadth.

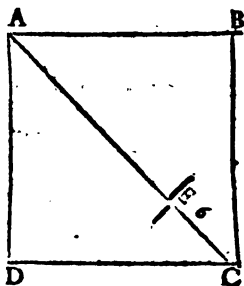
Answer. The Sides are 57 and 17.

60. Again, let 480 Soldiers be drawn up into an oblong Battle, so that the Sum of the greater and less Sides is 52. Required

quired the Number of the Soldiers of each Rank in Length and Breadth?

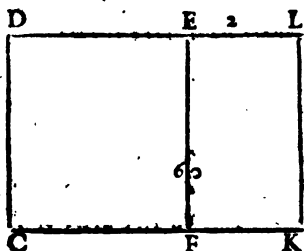
Answer. The Sides are 40 and 12.

61. *In the Square ABCD, is given the Difference of the Diagonal and the Side, that is $EC = 6$. Required the Side of the Square?*



Answer. The Side is 14.481.

62. *The Rectangle EK is added to the Square DF (being of the same Height) whose Breadth EL is given $= 2$, and also the Area of the whole compound Rectangle DK, $= 60$. Required the Side of the Square?*



Answer. The Side is 6:81.

63. A Man buys some Ells of Cloth for 70 Crowns; and finds that if he had 4 Ells more, he had then bought every Ell 2 Crowns cheaper. How many Ells did he buy?

Answer. He bought 10 Ells.

64. A Set of seven Companions dining at an Inn, the Reckoning in all came to 175 Shillings: But, before the Bill was paid off, two of them stunk away, and then the Club of those that remain'd came to 10 Shillings a Man more, How many were there in Company?

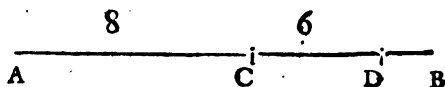
Answer. There were 7.

65. To divide the Number 21 into two parts, so that if the greater be divided by the

be less; and again the less by the greater and then the first Quotient being multiply'd by 4, and the latter by 25, the Numbers produced may be equal.

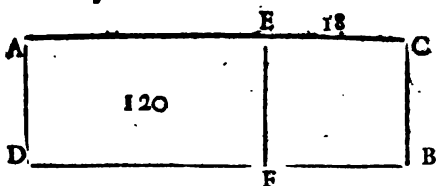
Answer. The Parts are 15 and 6.

66. Let the Line AB be divided in C , so that AC may be 8 and CD 6: We are to divide the same Line AB in D , so that the Rectangle under AD and DC may be equal to the Rectangle under AC and CB , or to the product from 8 and 6, which is 48. Required the Segment CD ?



Answer. The Segment CD is = 4.

67. Let there be a Rectangular Garden, $ABCD$, the Length of which AB is thrice the Breadth AD ; and reckoning 18 Perches from B towards A , that is BE , and reckoning EF parallel to AD , let the Area of the remaining Rectangle ED be given = 120 square Perches. What was the Length and Breadth of the said Garden?



Answer. The Length is = 30, and Breadth is = 10.

68. Let 600 Soldiers be disposed into an oblong Battle: Which the Colonel willing to make broader, finds that if he takes away 10 Ranks from the Length, he shall augment the Breadth with two Ranks. What was the Number of his Soldiers through every Rank in Length and Breadth?

Answer. The Length is = 60, and Breadth is = 10.

69. A Man buys a Horse, which he sells again for 56 Crowns, and gains as many Crowns in 100 as the Horse cost him. How much did he give for the Horse?

Answer. He gave 40 Crowns.

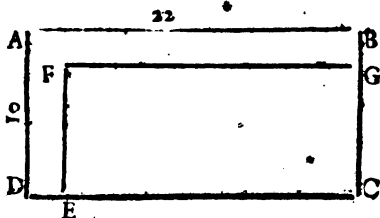
70. A certain Linnen-Draper buys two sorts of Linnen for 30 Crowns, one finer, the other coarser: An Ell of the finest cost as many Crowns as he had Ells: And also 28 Ells of the coarsest at such a Price, that 8 Ells cost

as

as many Crowns as one Ell of the finest. How many Ells of the finest Linnen did he buy, and what Price did he give for them both?

Answer. 4 Ells of the finest, at 4 Crowns per Ell, the coarsest cost half a Crown per Ell.

71. In a certain rectangular Garden, the Length of which AB , is 22 Perches, and the Breadth AD is 10, the Walk DG is to be made, in a Situation parallel to the Sides of the Figure, so that the Area of the said Walk or Gnomon DG may be equal to the remaining Rectangle FC , or that the Gnomon DG may be half of the whole Figure $ABCD$ propos'd. Required the Breadth of the said Gnomon DE or BG ?



Answer. The Breadth is = 3.917.

72. Of three proportional Numbers there is the middle Term given, = 12, and the Difference of the Extremes = 10. Required the Extremes?

Answer

Answer. The Extremes are 3 and 18.

73. Of three proportional Numbers there is given the Sum of the first and second, = 10, and the Difference of the second and third = 24. Required the several Numbers?

Answer. The Numbers are 2, 8, 32.

74. Of four proportional Numbers there is given the third = 12, also the Sum of the first and second = 8; besides the second Number being subtracted from its Square, the Remainder is to be the fourth. Required the said Numbers?

Answer. 3, 5, 12, 20. $3:5::12:20$.

75. Of four Numbers in continu'd Proportion there is given the Sum of the Means = 24, and likewise the Sum of the Extremes = 56, Required the said Numbers (supposing that the first is the least of all?)

Answer. The Numbers are $4:8::16:32$.

76. Two Country-women A and B, carry 100 Eggs together to Market; and in the Sale of them, one took as much Money as the other; but A (who had the largest and consequently the best Eggs) says to B, had I carry'd as many Eggs as you, I should have had

18 Pence for them; B replies, if I had brought as many Eggs as you, I should have had but 8 Pence for them. How many Eggs had each?

Answer. A had 60 and B had 40.

77. Two Country-men A and B sell their Corn at different Prices: A sells 20 Bushels; and B received for one Bushel as many Crowns as he sold Bushels: A perceives that if he had sold as many Bushels as B received Crowns, he should then have received 252 Crowns; but both together received 176 Crowns. How many Bushels did B sell, and what Price had A?

Answer. B had sold 6 Bushels, and A had 7 Crowns per Bushel.

78. Two Merchants sell 21 Ells of Cloth: The first sells 1 Ell for as many Crowns as is $\frac{1}{3}$ of the Number of Ells that the second had; and the second sells 1 Ell for as many Crowns as is $\frac{1}{4}$ of the Number of the Ells that the first had. The Sale being over, they had taken 48 Crowns in all. How many Ells did each sell, and at what Price?

Answer. A sold 6 Ells at 3 Crowns per Ell, and B sold 15 Ells at 2 Crowns per Ell.

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79. Two Merchants have a Parcel of Silk, the first 40 Ells the second 90: The first sells for a Crown $\frac{1}{2}$ of an Ell more than the second: When the Sale was over, they had taken between them 42 Crowns. How many Ells did each of 'em sell for a Crown?

Answer. A sold $3\frac{1}{2}$ and B 3 Ells.

80. To find a Number, to the quadruple of which if you add 91, the Whole shall be to the Square of the Number sought, as 3 to 4.

Answer. The Number is 14.

81. To find a Number, from the double of which if you subtract 12, the Square of the Remainder — 1, will be nine times the Number sought.

Answer. The Number is 11.

82. To divide the Number 19 into two Parts, so that the Sum of the Squares of the Parts will be 193.

Answer. The Parts are 12 and 7.

83. To divide 7 into two Parts, so that the Difference of the Squares, which are made from the triple of the less Part, and the double of the greater may be 17.

Answer.

Answer. The greater Part 4 and the less 3.

84. *A Man buys a Piece of Linnen, and by selling it again, he gains 12 Crowns — $\frac{1}{5}$ of what he bought it for: And finds by this Means, that he had gain'd as much for 100 Crowns, as the Linnen cost him. What Price was the Linnen bought and sold at?*

Answer. It cost 30 Shillings and sold it for 39.

85. *A Man buys 18 Ells of Cloth of different sorts and colour, suppose Red and Black; what he bought of each cost 40 Crowns: And he pays for every Ell of red Cloth 1 Crown more than for the black. How many Ells of each sort did he buy?*

Answer. 8 of Red and 10 of Black.

86. *A Man buys 123 Pounds of Pepper, and as many of Ginger; and received for a Crown one Pound of Ginger more than of Pepper. So that the whole Price of the Pepper came to 6 Crowns more than the Price of the Ginger. How many Pounds of each did he buy for a Crown?*

Answer. 4 Pounds of Pepper and 5 of Ginger.

87. *A Man buys 80 Pounds of Pepper, and 36 Pounds of Saffron, so that for 8 Crowns*

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Crowns he had 14 Pounds of Pepper more than he had of Saffron for 26 Crowns, and what he laid out amounted to 188 Crowns. How many Pounds of Pepper had he for 8 Crowns, and how many of Saffron for 26?

Answer. 20 Pounds of Pepper and 6 of Saffron.

88. *A and B between them owe 174 Pounds: A pays 8 Pounds a Day, and B pays the first Day 1 Pound, the second 2, the third 3, and so on. In how many Days will they clear the Debt, and how much did each of them owe?*

Answer. The Debt will be paid in 12 Days, in which Time A pays 96 and B 78 Pounds.

89. *A certain Man intends to travel as many Days as he has Crowns: It happens that every following Day of his Journey he had as many Crowns as he had the Day before, besides two Crowns over and above; and when he came to his Journey's End he finds he had in all 45 Crowns. How many Crowns had he at first?*

Answer. He had 5 Crowns.

90. *A certain Traveller goes 9 Miles a Day, three Days after another follows him, who the first Day travels 4 Miles, the second 5, the third 6, and so on, gaining a Mile every*

very Day. In what Time will he overtake the former?

Answer. In 14.678881 Days.

91. Two Travellers set out at the same Time from two Cities, the one from A and the other from B, which are 70 Miles distant from one another; one of them goes 6 Miles every Day, and the other 2 Miles the first Day, 2 and an half the second, three the third, and so on, adding half a Mile to every Day's Journey. In what Time will they meet with one another?

Answer. In 7.30891 Days.

92. Again, Two Travellers set out at the same Time from two Cities, the one from A and the other from B, which are 120 Miles distant from one another; the first goes 5 Miles a Day, and the other 3 Miles less than the Number of Days in which they meet. When will they meet?

Answer. In 10 Days.

93. A Post sets out from A towards B, who travels 8 Miles a Day: After he had gone 27 Miles another sets out from B to meet him, who goes every Day $\frac{1}{2}$ of the whole Journey.

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110 *Arithmetical Problems solv'd.*

ney or Distance of the Places *A* and *B*, and meets the first Post after so many Days as is $\frac{1}{10}$ of the said Distance. Required the Distance of *A* and *B*?

Answer. The Distance is 180 Miles.

94. Two Merchants *A* and *B* go Partners, *B* brings 420 Crowns; and *A* receives out of his Gains 52 Crowns, and the Sum of both their Shares of Stock and Gains, is 854 Crowns. How much did *A* bring, and how much did *B* receive out of the Gains?

Answer. *A* brought 70, and *B* gain'd 312 Crowns.

95. *A* Son asks his Father how old he was? his Father replies thus; If you take 4 from my Age, the Remainder will be thrice the Number of your Years: But if you take 1 from your Age, half the Remainder will be the Square Root of my Age. Required the Age of the Father and Son?

Answer. The Father 49 and the Son 15.

96. To find two Numbers, the Sum of whose Squares may be 317, and the Product, if they be multiply'd by one another, 154.

Answer. The Numbers are 14 and 11.

97. To

97. To find two Numbers, the Product of which may be 108, and the Difference of the Squares 63.

Answer. The Numbers are 12 and 9.

98. Two Farmers sell two sorts of Corn: A sells 6 Bushels; B receives in all, for his, 20 Crowns:—Now, says B to A, if we add the Number of my Bushels to the Number of your Crowns, the Sum will be 28: Says A to B, and if I add the Square of my Crowns to the Square of your Bushels, the Sum will be 424. How many Bushels did B sell, and how many Crowns did A receive?

Answer. B sold 18 Bushels, and A received 10 Crowns.

99. To find two Numbers, the first of which $+ 2$, multiply'd into the second $- 3$, may produce 110; and on the contrary the first $- 3$, multiply'd by the second $+ 2$, may produce 80.

Answer. The first is 8 and the second 14.

100. If the Sun moves every Day one Degree, and the Moon 13 Degrees; and at a
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12 *Arithmetical Problems solv'd.*

certain Time the Sun be at the Beginning of Cancer, and in 3 Days after, the Moon in the Beginning of Aries: The Place of their next following Conjunction is demanded.

Answer. 10 Degrees and $\frac{2}{3}$ of Cancer. For

$$\frac{13 \times 1 \times 90 + 13 \times 1 \times 3}{13 \times 1 - 1 \times 1} = \frac{1209}{12} \text{ or } 100 \frac{2}{3} \text{ from Aries } 00 \text{ Degrees; so will come out } 10 \frac{2}{3} \text{ of Cancer.}$$



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The Fourth P A R T; BEING A

MATHEMATICAL MISCELLANY, &c.



Notwithstanding I have already endeavoured to answer what Expectation the Title may have raised in the Mind of the curious Reader; yet to render this little Manual still more acceptable, I shall subjoin a fourth Part, containing some necessary Rules concerning the Formation of a pleasing and diverting *Ænigma*, and *Arithmetical Questions*, with Examples of each: Also how to observe the *Eclipses*, and to know the fixed Stars; with some memorable Observations concerning *Time* and the Equation thereof, *Easter*, and Ship's Distance at Sea, &c.

Seeing *Ænigma's* have of old been the Diversion of Princes, and Entertainment at Feasts, and of late revived among our annual Writers of Diaries, it will not be amiss, for the Information of their ingenious Assistants and Contributors, to exhibit some proper Rules for their Composition generally allow'd of.

An *Ænigma* is then an ingenious and beautiful obscuring the plain est Things; which when discovered, strikes the Soul with Admiration; while we pleasingly wonder, to see how it was possible to lay, as it were, a Veil before the Sun: It is an artificial representing a Subject under the Shape of another, with so much Cunning, that hides a Thing while it discovers it, and persuades us it is something else than what it is really design'd for.

First,

First, That they propose all their *Ænigma's* on Subjects generally known.

Secondly, That they ascribe to no Subject a Property or Quality incoherent to, or inconsistent with it. As for Example: In an *Ænigma* upon *Snow*, it would be very absurd to say, it discolours all the Surface of the Sea, or defies the Fury of *Ætnæa* Flames.

Thirdly, That they propose not particular Qualities for general. For tho' by *Synecdoche* we say *Æbiops Albus*—*quia albos habet dentes*; yet it would be very improper in an *Ænigma* upon a *Blackamore*, to make him speak in general Terms—I'm *white as Down of Swans* or *falling Snow*. Another Caution which may be reduced to this Rule is, That they propose not certain Numbers for uncertain.

Fourthly, That they have a Regard to Time. In treating on Subjects which have been, but now are not: They ought always to speak in the *Preterperfect Tense*, not in the *Present*. As were I to write an *Ænigma* on *Noah's Ark*, 'twould be ridiculous I should say, all Creatures living are within its Womb. This would confine the Answerer's Thoughts entirely to Things *now in being*. To this Rule may also be added the Regard they ought to have to *Place*.

These are Maxims so plain and common, that it were an Absurdity, one would think, to violate any of them; and yet it were to be wished some *Ænigmatists* in the *Diaries* would be ty'd down to them. Whenever they are violated, 'tis certain the Reader is impos'd upon; for in solving an *Ænigma*, until we can bring it to answer in every Particular, we cannot suppose we have found the Solution. If therefore the Proposer imposes a Fallacy upon us, tho' never so small, 'tis still an Objection to our Answer, and we go on beating our Brains in endeavouring to apply to something, that which perhaps is not applicable to any thing,

Example I.

THE charming *Philis* once was wond'rous fair,
 Each Youth's Delight, her Parents only Care,
 Admir'd and lov'd by all the neighb'ring Swains,
 And own'd the loveliest Nymph that grac'd the Plains.
Orant she lov'd, of mean and low Degree,
 A Servant in her Father's Family.

Her Parents knew how she her Love had plac'd,
 Yet blâm'd her not, because they saw 'twas chaste;
 One Hour to her each Morn they freely grant,
 For private Converse with her dear *Orant*.
 Unskill'd in Language he her Heart beguiles,
 With amorous Looks, and with obliging Smiles;
 All Shapes he wore, yet ne'er by her was seen
 Without a beauteous Face and lovely Mien.

When thus he had her youthful Heart betray'd,
 A foul Distemper seiz'd the blooming Maid;
 Long time a burning Fever rag'd within,
 And rising Pustules spoil'd her lovely Skin.

While thus she lay, th' indulgent Mother near,
 O give me Leave once more to see my dear!
 My dear *Orant*! She said, 'twill ease my Pain,
 If I can once behold *Orant* again:

Why must I now in vain with Tears implore
 That Favour, which was ne'er deny'd before?

HER Mother cry'd, my Child, take no Offence,
 Your Suit is now of dang'rous Consequence;
 I can't permit you once to see your Love.

'Till Time shall this Disorder quite remove.

At length perceiving she was left alone,
 And her Desire, as yet, fulfill'd by none,
 Up starts th' impatient Maid without Delay,
 And to *Orant*'s Apartment found the Way;

She found the Object of her Passion too,
And cry'd, *What says he to his Phillis now?*
You're foul, you're monstrous grown (said he) therefore
Henceforth I'll see that loathsome Face no more.

IMPATIENT of the Wrong, she turn'd aside,
And snatch'd a Dagger, which by Chance she spy'd.
Then, half distracted, to the Scorners flew,
And at his Breast the pointed Weapon threw:
I'll make thee feel, ungrateful Wretch, she said,
The just Resentment of an injur'd Maid.
Pierc'd thro' and thro', he fell upon the Ground,
While she, without Remorse, pursu'd the Wound:
With unrelenting Rage she trampled o'er
His Body, which with utmost Rage she tore,
And strow'd his mangled Limbs upon the Floor.

LADIES, *no doubt this seems a monstrous Tale*
But if I should the Mystery reveal,
You'll own at least the Story may be true,
And has been acted o'er by some of you.

Answer. *A Lady beholding her Fate in a Looking-Glass, after the Small-Pox.*

Example II.

FROM Shrubs and from Trees and vast Caverns below,
And the Sweat of Mens Bodies, our Beings we owe:
But we're odd kind of Beings, and strange Pranks have play'd,
Some we have delighted, and some made afraid.
If two of us meet, Sir, nay, if we be three,
All Things topsie-turvy we turn presently:
But then if our Number increas'd is to four,
We set all Things to rights, Sir, as they were before.
No Hands ever had we, or Colour e'er saw,
Nor ever us'd Croyon or Pencil to draw:

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Yet we paint with such delicate Colour and Shade,
And in such true Proportion ~~our~~ Figures are made,
That we challenge *Van Dike*, and the fam'd *Angelo*,
Such excellent Pieces as ours are, to show.

Answer.

By the Help of Telescope Glasses may be represented in a darkned Room. (as I have often my self experienced) the most lovely and charming Colours, Proportions and Distances of all outward Objects, vastly surpassing all that ever the most celebrated Painters could perform. A clear Account of this most wonderful and glorious Experiment. I shall here give you from the best Authors, and from my own Experience.

Procure a good Convex or Plano-Convex-Glass; or, if you take the Object-Glass of a Seven-Foot-Telescope, there is none hardly to be preferred before it; there being several Inconveniencies in Glasses, that draw above or under that Distance.

Make choice of a Room that hath got a North Window (tho' an East or West may do pretty well) and let it be well darkned, so that no Light can come in, but at the Hole where your Glass is to be placed: Then make a Hole in the Shutter of the North Window, about an Inch (or very little more) in Diameter, and leave open the Casement, if there be one; for there must be no Glass beyond the Hole; then fasten the Glass with its Center, in the Center of the Hole, by some small Tacks or Nails, to the Shutter, and at the Distance your Glass draws, hang up a white Sheet; (or, which is all one, move the Sheet to and fro. till you find the outer Objects are represented on it very distinctly) then fasten the Sheet to the Ceiling with Nails: Then will, whatever is without the Hole, and opposite to it, be represented on that Sheet, with such exquisite Exactness, as far surpasses the utmost Skill of any Painter to express. For if the Sun shine brightly

brightly on the Objects, you will have the Colour of all things there in their natural Paint, and such an admirable Proportion of Light and Shadow, as is impossible to be imitated by Art; and I never saw any thing that comes so near this natural Landskip: But if the Sun do not shine, the Colours will be hardly visible; and you must by all means avoid the Sun's shining near the Hole, for then all things will be confus'd.

And here you have not only the Representation of outward Objects, but their very Motion also, expressed on your white Cloth: If the Wind move the Trees, Plants or Flowers without, you have it within on your lively Picture; and nothing can be more pleasant, than to see how the Colours of the moving Parts will change as they do without, by their being in various Positions obverted to, or shaded from the Light. The Motion of any Birds, Flies, or other Insects, are painted also in the same Perfection; and the exact Lineaments of any Person walking at a due Distance without the Glass, will be also expressed to the Life; and all their Motions, Postures and Gestures, will as plainly appear on the Cloth, as they do to any ones Eye without.

And nothing is wanting to render it one of the finest Sights in the World, but that all things are inverted, and the wrong End upwards; to remedy which, take a common Looking-Glass, of twelve or fourteen Inches square, and hold it under or near the Chin with an acute Angle to your Breast: For if you do so, and look down into it, you will see all things upon the Sheet inverted in the Glass; and so (in this Case) will be restored to their natural and erect Positions; and this Reflection also from the Glass, gives it a Glaringness that is very surprizing, and makes it look like some magical Prospect; and the moving Images, like so many Spectrums or Phantasms. And no doubt but there
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are many Persons, that might easily be imposed upon with such a Scene; and would not be persuaded but that it was downright Conjuratation.

I have (saith Mr. Harris) made use of this Experiment to convince some credulous Persons that those are abused and imposed upon who see Faces in the Glasses of some cheating Knaves amongst us, who set up for cunning Men. and Discoverers of stolen Goods, &c. and have satisfied them, that much more may be done by this and some other Optical Experiments, and that without the Help of the Devil too, than by any of the clumsy Methods used by these Vermin.

If the Glass be placed in a Sphere, or Globe of Wood (having an Hole, as large as the Glass, bored thro' it) which like the Eye of an Animal, may be turned every way, to receive the Rays coming from all Parts of the Objects, it will be of good Advantage to the Experiment

You may with this Glass also (as well as with a Concave one) make that little Machine called the Magical Lanthorn; by Means of which are represented on a Wall in the dark, many Phantoms and terrible Apparitions, which are taken for the Effects of Magick, by those that are ignorant of the Secret. The Theory of this Lanthorn is fully explained by Mr. *Molyneux*, in his excellent Book called *Dioptr. Nova*. Prop. 56, p. 183. and the Machine at large described; to which I refer my curious Reader.

And thus is one Part of the *Example* explained. And this also explains two more of the former Lines in these Words,

*But we're odd kind of Beings and strange Pranks have play'd,
Some we have delighted, and some made afraid,*

By which is meant, those glorious Representations of Objects in a darkned Room, upon a white Cloth (or Paper) as I have before described; and the frightful Apparitions made by the Magick Lanthorn just now mentioned. As for the two first Lines,

From

*From Shrubs and from Trees and vast Caverns below,
And the Sweat of Mens Bodies, our Beings we owe;*

Is meant the Materials by which Glass is made; which is from the Shrub called *Kali*, and *Wood Ashes*, and divers other Things, which, with Coals drawn out of the Bowels of the Earth, are melted; and is the hottest Work in the World, in Blowing and Grinding, causing the Operators to sweat in a plentiful Manner.

SECTION II.

Some useful and necessary Hints for the pleasing Composition of proper Arithmetical Questions; by Persons of a good mathematical Genius.

1. **T**HE most natural Method in answering the Questions, should be a little regarded in the Composition.

2. No Question that can be answered two ways should be allow'd of, which will necessarily lead some from the expected Answer.

3. Nothing that is very paradoxical, much less naturally impossible, and void of Demonstration, should be put for an *Arithmetical Question*.

4. No ambiguous or doubtful Words should be used, but such as are plain and easy to be understood.

5. We should use the same Terms of Art with the latest and best Authors; or at least our Terms and Phrases should be so plain and easy, as that none may be mistaken or deceived by them: For I think

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think it is much better and more improving, to invent something ingenious than abstruse. Nor do I see any great Benefit or Difficulty in puzzling Mankind, and racking their Brains; nor is it necessary when there is such an infinite Variety in the Mathematicks of pleasant and profitable Propositions. All kind of Learning is difficult enough, especially the Mathematical, to take up the short Interims of our Time, without being made more tedious and laborious; therefore we should make it our chief Aim to facilitate and abridge it.

Example I.

WHEN fleecy Skies had cloath'd the Ground,
With a white Mantle all around,
Then with a Greyhound, snowy fair,
In Milk-white Fields we cours'd a Hare;
Just in the midst of a Campaign,
We set her up, away she ran:
The Hound (I think) from her was then,
Just thirty Leaps (or three times ten)
Oh! it was pleasant for to see,
How th' Hare did run so timorously,
But yet so very swift that I,
Did think she did not run, but fly:
When th' Dog was almost at her Heels,
She quickly turn'd, and down the Fields
She ran again, with full Career,
And 'gain she turn'd to th' Place she were;
At ev'ry Turn she gain'd of Ground
As many Yards as the Greyhound
Could leap at thrice, and she did make
Just six (if I do not mistake)

Four

Four times she leapt for the Dog's three,
But two of the Dog's Leaps agree
With three of hers. Now pray declare,
How many Leaps he took to catch the Hare.

Answer.

LAST Winter when the Fields were cloath'd,
And to the Milk-white Snow betroth'd,
When Trees were crop't by frosty Weather,
Their Buds and Leaves lay mixt together
Sol did in *Capricorn* appear,
And made short stay in this our Hemisphere;
The Time. I very well remember
Was in the Middle of *December* :
A Knot of jovial Blades did meet,
And that our Mirth we might compleat,
Into the snowy Fields we went,
To course the Hare was our Intent;
We beat the Fields with wond'rous Care,
At last we found a boxing Hare,
Just in the midst of a Campaign
We set her up, away she ran,
With nimble Foot, o'er a large Plain.
Don't wonder I use Mr. *Walker's* Verse,
When I this coursing Match rehearse;
For we had there the same Greyhound:
And with him cours'd the Hare around;
I well observ'd when we did find her,
The Dog was thirty Leaps behind her.
It pleas'd me so, methinks I see
The frighted Hare run timorously :
The Dog being almost at her Heels,,
With Motion swift about she wheels.
With full Career away she ran
To th' Place where she at first began;

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Six Turns in all the Hare did make,
 Their Number you did not mistake;
 Proportion due I did compare,
 Between the Leaps o' th' Dog and Hare,
 For her four Leaps the Dog made three,
 The Sport was charming for to see;
 Her Three, did two of his contain,
 So one in nine the Dog, did gain;
 How many Leaps to catch the Hare
 The Dog did take, I shall declare.
 Four hundred and just thirty two
 They were, and so, good Sir, adieu.

Example II.

Mr. Richard Wrag made a Voyage to Constantinople with Mr. Barton, Queen Elizabeth's Ambassador: and during his stay there, upon the 16th of July, 1594; for his Diversion he made a Trip to the Euxine or Black-Sea; his Relation of it is thus, The 16th of July, accompanied with some other of our Nation, we went by Water to the Black-Sea. Being 16 Miles from Constantinople; the Sea being all the Way thither. little broader than the Thames: Both Sides of the Shore being beautified with fair and goodly Buildings: At the Mouth of this Bosphorus lieth a Rock some 80 Yards from the Main Land, whereupon standeth a white Marble Pillar, call'd Pompey's Pillar, the Shadow whereof was 23 Foot long, at 5 of the Clock in the Forenoon (which is all he says of it to our Purpose; leaving the Height of the Pillar undetermined.) Now the Latitude of the Place being found to be 41 Deg. 8 Min. it is required to find the Height of the Pillar.

Answer.

Answer.

The Sun's Longitude July 16, Anno 1594, at 9 of the Clock in the Forenoon. is, according to the Caroline Tables, 2 Deg. 47 Min. 31 sec. in Leo. Thence,

1. To find the Sun's Declination.

	deg. min. sec.
As Radius or Sine of _____	90 : 00 : 00
To the Sine of the Sun's Distance from the next Equinoctial Point: _____	57 : 12 : 29
So is the Sine of the Sun's greatest Dec. 23 :	30 : 00
To the Sine of the Sun's Declination at the Day and Hour aforesaid. _____	19 : 35 : 06

2. To find the Sun's Height.

As the Radius or Sine of _____	90 : 00 : 00
To the Corangent of the Poles Height 48 :	52 : 00
So is the Sine of the Sun's Distance from the Hour of 6. viz. _____	45 : 00 : 00
To the Tangent of an Arch, viz. _____	38 : 59 : 40
Which being subtracted from the Complement of the Sun's Declination, say,	
As the Cosine of the Arch found _____	51 : 00 : 20
To the Cosine of the remaining Arch. of the Sun's Distance from the Pole _____	58 : 34 : 46
So is the Sine of the Pole's Height _____	41 : 08 : 00
To the Sine of the Sun's Height at the Day and Hour aforesaid. _____	46 : 14 : 32

3. To find the Height of the Pillar.

As Cosine of the Sun's Height _____	43 : 45 : 28
To the Length of the Shadow 23 Feer,	
So is the Sine of the Sun's Height _____	46 : 14 : 32

To the Height of the Pillar 24.0196 Feet.

The Operation of Logarithms is left to the Reader to perform at his Leisure.



SECTION III.

By what Means we may know the Stars in the Heavens.

1. **BY** having the Picture or Representation of the Constellation by you, and knowing one or more Stars of the same Constellation, by comparing the Stars in the Picture or Figure, and those in the Heaven: and considering their Situation Distances and Magnitudes in the one, you may easily find out those in the other.

2. By the passing of some of the Planets, but especially the Moon, thro' the Signs, or by some Eminent Stars.

3. By their coming to South, and if withal, you have their Height given, and then by a Quadrant find their Height in the Heavens, you may, with great Certainty and Ease find them out.

4. By their Rising and Setting, when and on what Point of the Compass; or by their Azimuth and Altitude, using only a Quadrant and Compass.

5. By some Instrument as the Hemisphere, Globes, or a Speaking-Tutor, who can point them out with Speed and Certainty.

To distinguish Planets from fixed Stars.

Planets rarely twinkle, Jupiter and Venus are bigger than fixed Stars, they shift their Places from a fixed Star considerably in a Week or two: Also by

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an Ephemeris; see what Constellation they are in: Jupiter and Venus are of the first Magnitude, Mars of the second. Saturn and Mercury of the third: Saturn of a Lead Colour, Jupiter of a Silver, Mars of a Copper, Venus like glistening Silver, not far from the Sun, and Mercury like Quicksilver, seldom visible, and always near the Sun.



SECTION IV.

Concerning ECLIPSES, and how to observe them with Safety, Pleasure and Profit.

WHEN we consider the Penetration and Contrivance necessary to lay the Foundation of Astronomy, we cannot but admire its first Inventors; such as *Thales Milesius*, who is said first to have predicted Eclipses: His Scholar *Anaximander*, who found out the Globous Figure of the Earth, the Equinoctial Points and Principles of Dyalling, and made the first Sphere or Image of the Heavens: And also *Pythagoras* or his Scholars, to whom we owe the Discovery of the best System of the Planets, who were probably assisted by the *Chaldeans* and *Egyptians*, among whom (*Josaphat* informs us) *Abraham* read Lectures of Astronomy and Arithmetick, which Sciences the Egyptians understood nothing of, 'til *Abraham* brought 'em from Chaldaea into Egypt, and from thence they passed to the Greeks. See Antiq. Book 1. Ch. 5.

But the Astronomers of our Age have attained to much greater Perfection in these Matters, especially in Eclipses of the Sun, which are much more difficult than Lunar. The Eclipse of the Moon has the same Appearance to all Spectators at the same Instant:

Instant: Whereas that of the Sun may appear to one Part of the Earth totally obliured, to another but in Part, on its *North Side*, to a third on its *South Side*, and to a fourth not at all; and all this at the same Moment of Time.

Hence it is, That the Lunar Eclipses equally happening at the same Instant to that Hemisphere to which the Moon is then visible, may be reduced to any other Meridian by allowing the Time, belonging to the Difference of Meridians after the Calculation is ended: But an Eclipse of the Sun must be calculated for every different Meridian, if you will have its true Appearance, which much encreaseth its Difficulty, and among other Things made the Antients to err so much, and so often herein: Wherefore, after the true Conjunction is found, change the Time by the Tables into the Time proper to another Meridian, by allowing its Difference, to which Time and Place find the Parallax, &c. For the Parallax of the Moon differs in every Climate, on which the visible Eclipse of the Sun principally depends.

The Moon having only a precarious Light, is covered with real Darknesh, whenever the Earth robs it of the Sun-Beams. But the Sun, on the contrary, which is luminous, or rather Light it self, can never be really darkned by the Moon's covering it, only in Appearance to the Spectators under its Shade; it is not the Sun but the Earth that is in Darknesh. Hence it may more properly be term'd an Eclipse of the Earth than of the Sun; yet because of Custom, and the seeming Darknesh over the Sun, I retain the common Phrase of the Eclipse of the Sun.

In general, there are more Eclipses of the Sun than of the Moon, but Eclipses of the Sun in any particular Place are much fewer than of the Moon, because the Moon's Shadow is less than the Earth's, and consequently does not involve any given Place
of

of the Earth so oft as the Earth's Shadow does some Part of the Moon. The Moon oftner takes away the whole Sun from the Earth, than the Earth takes away the whole Sun from the Moon; the Body of the Earth being larger, receives more Transits of the Moon's Shadow than the Moon of the Earth's Shadow; and because the Sum of the Semidiameters of the Moon and the Earth is never less than 54 Minutes, and the Semidiameters of the Sun and Moon never greater than 34. The Eclipse of the Moon may happen in a greater Latitude of the Moon than the Solar; and in respect of one and the same Place upon the Earth, the Eclipses of the Moon will be more frequent; tho' in respect of the whole Earth, Solar Eclipses may exceed in Number.

Moreover, because for many Days together, the Sun's Place is once every Year but a little distant from either Node, during which time there happen generally two Syzyges; and consequently Eclipses which are the greater, the nearer any New or Full Moon happens to the said Nodes, which Nodes are the Sections of the Moon's Orbit with the Ecliptic: In a Year there happen seldom less than two, or more than six Eclipses.

Astronomers affirm the Sun may be eclipsed more than 12 Digits, and the Moon 22 (if it had them) for a Digit is one 12th Part of their Diameter. The Sun is seldom totally eclipsed in one Place, the Moon often: And the greatest Shadow the Moon hides, is not above 200 Miles, being the greatest Difference of the Sun and Moon's Diameter, which according to the obliquity of Horizons is greater or less. The End of the Shadow, whether of the Moon or Earth, falls short of the other Planets, and therefore they eclipse none but each other.

The Sun's Eclipse arises sooner to those that inhabit the *Western* Parts, and later to those more *Easterly*, because the Moon's proper Motion from *West* to

to *East* is swifter than the Sun's near 13 times; and therefore it begins on the *Western* Limb of the Sun, which Part is first restored to Light again: And if the Moon's visible Latitude be *North*, the *North* Part, but if *South*, the *South* Part of the Sun is darkned, because the Moon intercepts the Light of the Sun, on the same Side of the Ecliptick the Moon appears.

The Sun's Eclipse lasts not so long as the Moon's, the Sun's in any Place seldom exceeding two Hours, but the Moon's sometimes more than four; because the Moon each Hour goes through half a Degree about the Length of the Sun's apparent Diameter, which the Moon must be one Hour covering, and another Hour uncovering, about two Hours in all. Solar Eclipses also are very different each from other, not only because of the unequal and uncertain Motion of the Moon, both true and apparent, the greater or lesser visible Latitude of the Moon's Distance from the Sun, and unequal Distance of both the Luminaries from the Earth; tho' Eclipses may happen pretty near the same Time and Place, yet they will not, for the above Reasons, be of the same Quantity and Duration; for this Rule is certain, *The Heavenly Motions are incommensurable among themselves, nor have the same Phenomena in every Respect, return'd alike in any Place*

For the newest and exactest Method of calculating Eclipses, see Dr. Gregory's Astronomy, Book 4. Sect. 7. 8. and Mr Flamsteed's Doctrine of the Sphere in Sir Jonas Moor's System of the Mathematicks.

Eclipses are of manifold Uses in Astronomy, Geography, Chronology, and Navigation, to correct their Tables, Maps, Globes, Account of Time, and contribute very much to the Discovery of Longitude both by Sea and Land; and by the Wings of Eclipses and Parallaxes the Mind of Man flies up, and penetrates into the Celestial Regions: These are the Charms, as saith the Poet, *which draw down the*

the Sun and Moon on Earth; or more truly the Knowledge of them to the inquisitive Inhabitants of the Earth; nor do I know a more evident and illustrious Proof of Astronomical Truth in Hypotheses, or Tables, than may be had from Solar and Lunar Eclipses.

To behold the Eclipse without Hurt to the Eyes

SOME simply prick a small Hole in a Sheet of Paper, others use a Looking-Glass; but a better Way is with coloured or smoaked Glass, which defends the Eye from the Beams of the Sun, or by a Burning-Glass, reflecting it on a clean Sheet of Paper, held twice as far from the Paper as for Burning.

Tho' I do not here intend to prescribe a Method to those Gentlemen that are furnished with Astronomical Machines, such as large Quadrants, Sextants, whereunto are affix'd Telescopic Sights, yet I shall humbly offer a ready Astronomical Apparatus for others.

Prepare a Sheet of Paper, whereon is drawn a Circle; about 6 Inches Diameter, divide its Circumference into 360, its Diameter by 6 Concentrick Circles, into 12 equal Parts for the Digits; and another Diameter for Decimal Parts into an 100, whereby the Proportion of the light and dark Parts to each other may be known; the 360 on the Limb, may serve to determine the Inclination of the Cusps of the Shade, this paste on some Wall, or Board which is better.

Then Rule a Paper, like a Surveyor's Field-Book, in 9 or 10 Columns, for the Uses following.

Observations

Observations common to the Eye: as Appearances of the Sky, Colour of the Eclipse, Stars seen, Candles lighted, or Birds flying towards their Nests.	Number of Observations.	Digits and Parts.	Decimal Parts.	Time by Pendulum.	Time by a Sun-Dial.	Sun's Altitude.	Time Corrected.	Astronomical Observations: as Sun's Azimuth, Inclination of the Cusps, Semidiameter of the Moon, bigger or less than the Sun, whether it grows bigger or less; whether the Moon has an Atmosphere, especially to be observ'd, where total Darkness happens by red Streaks of Light before and after it; also how long they are visible.
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Then prepare a large Prospect with two Glasses, the Eye-Glass Concave, the Object Convex, and affix it to a Surveying Instrument, or the like, with a Ball and Socket, that it may move higher or lower, or to any Point of the Compass; and let it stand at such a Distance from the Sheet aforesaid, as just to reflect the Species of the Sun to the like Diameter already thereon drawn; which let one or two mind how the Shade commences, another observe the Sun's Altitude by a Gnomon and End of its Shadow, whether Wall or Stake; if you have no Quadrant large enough let some other mind the rectified Pendulum and Sun-Dial, and give Account of the mean and apparent Time and Register in their proper Columns; particularly noting the Beginning and End of total Darkness, and of the whole, when also each Digit is eclipsed, if the Air be clear, also the Angle of Incidence, &c.

Note, The principal Things to be minded are,
 1. the exact Time of the Beginning and End of the Eclipse, and of total Darkness when and where such Eclipses happen. 2. The Duration of total Darkness. 3. The Difference of the Colour and Temper of Light. 4. The red Streaks of Light just preceding and following the total Darkness, being Indications of an Atmosphere about the Moon.

The Method of observing Eclipses of the Moon.

Eclipses of the Moon, are observed for two Principal Ends; one Astronomical, that by comparing Observations with Calculations, the Theory of the Moon's Motion may be Perfected, and the Tables thereof Reformed: The other Geographical, that by comparing among themselves, the Observations of the same Ecliptick Phases made in divers Places, the Difference of Meridians or Longitude of Places may be Discerned.

The Knowledge of the Eclipses, Quantity and Duration, the Shadows, Curvity and Inclination &c. conduce only to the former of these Ends. The exact time of the beginning Middle and End of the Eclipses, as also in Total ones. The beginning and end of Total Darkness, is useful for both of them.

But because in Observations made by the bare Eye these times considerably differ from those with a Telescope, and because the Beginning of Eclipses, and the End of Total Darkness, are scarce to be observed exactly even with Glasses, (none being able to distinguish between the true Shadow and *Penumbra*, unless he hath seen for some Time before, the Line separating them pass along upon the Surface of the Moon)

Lastly, because in small Partile Eclipses, the Beginning and End in Total ones of small Continuance in the Shadow, the Beginning and End of Total Darkness are unfit for Nice Observation, by reason of the slow Change of Appearances which the oblique Motion of the Shadow then causeth. For these Reasons, the following Method is necessary, to accomplish the Geographical Ends in observing Lunar Eclipses, free (as far as is possible) from the forementioned Inconveniencies.

First, it shall not be practicable without a Telescope. Secondly, the Observer shall always have

Opportunity, before his principal Observation, to note the Distinction between the true Shadow and *Penumbra*. And Thirdly, it shall be applicable to those Seasons of the Eclipse, when there is the suddenest Alteration of the Appearances for these Intents. Let there be of the eminentest Spots dispersed over all Quarters of the Moon's Surface, a select Number generally agreed on, to be constantly made use of to this Purpose, in all the Parts of the World; as for Example, those which Mr. Hevelius calleth *M. Sinai*, *M. Aina*, *M. Porphyrius*, *M. Serorum*, *Inf. Bsbica*, *Inf. Creta*, *Palus Maotis*, *Palus Maraotis*, *Lacus Niger Major*, Let in each Eclipse, not all, but (for Instance) three of these Spots which lie nearest to the Ecliptick be exactly observed, when they are first touched by the true Shadow, and again when they are completely entered into it, also in the Decrease of the Eclipse, when they are first fully clear from the true Shadow. For the accurate Determination of which Moments of Time, (that being in this Business of main Importance) Let there be taken Altitudes of remarkable fixed Stars on this Side the Line, of such as lie between the Equator and Tropic of *Cancer*; but beyond the Line of such as are situate towards the other Tropic and in all Places of such as at the Time of Observation, are about four Hours distant from the Meridian,

To observe a Solar Eclipse.

First prepare a Room well darkned, into which cast the Sun's Rays through a Telescope of a competent Length, as aforesaid, to the End of which fix a Paper, pasted on a small Board, at such a Distance that the Species of the Sun may appear thereon about five or six Inches over; then divide both his Periphery into three hundred and sixty Degrees, &c. For the better observing the Inclination of the Cusps of each Phasis, and its Diameter into Digits and Parts, by concentrick Circles for the measuring the obscured

obscured Parts. Cross those Circles at right Angles to which hang a Line and Plummet by which you may keep the vertical and horizontal Circles in their due Situation.

There is a certain Period of Eclipses, called by Dr. Halley the *Chaldean, Saros*, which, in Leap-Years is eighteen Years, eleven Days, seven Hours, forty three Minutes and fifteen Seconds; but in a common Year is eighteen Years, ten Days, seven Hours, forty three Minutes fifteen Seconds. This Period may serve very well for common Use to examine Eclipses by, but not to trust to for the precise Time.

Its Use, by Examples from Black-Monday, which was

Y. D. H.
1652 March 28 : 12
18 10 : 7

*And from the same to
move backwards.*

1670 April 8 : 5
18 11 : 7 *because Leap-Year*

Y. D. H.
1652 March 28 : 22
18 10 : 7

1688 April 19 : 12
18 10 : 7

1634 March 18 : 15
18 10 : 7

1706 April 29 : 19
18 11 : 7 *because Leap-Year*

1616 March 8 : 8
18 11 : 7

1724 May 11 : 2
18 10 : 7

1598 Feb. 25 : 2

1742 May 21 : 9
18 11 : 7 *because Leap-Year*

On which Day a-
bout Noon hap-
pened such ano-
ther dark Day ;
and therefore a-

1760 June 14 : 16

about an Age ago was denominated *Black-Saturday*.

Note. In all these Days past were great Eclipses of the Sun, either visible or invisible.

I will close this *SECTION* with a Recapitulation of the Difference between an Eclipse of the Moon, which is

1. A true Obscuration or Defect of the Moon.

2. 'Tis from the Shade or Penumbra of the Earth interpos'd betwixt Moon and Sun.

3. It can only be seen by Night, or near it.

4. It only happens in the true Opposition.

5. It appears in all the nocturnal Hemisphere, every where of the same Magnitude and Duration.

6. It begins in the *Eastern* and ends in the *Western* Limb of the Moon.

7. If the true Latitude of the Moon be *North*, then in the Middle of the Eclipse the obscure Part of the Moon tends towards the *South*, if the Latitude be *South* it tends towards the *North*.

8. Its greatest Duration is when the Moon is in *Perigæo* about four Hours.

which is

1. A true Obscuration, not of the Sun, but of the Earth.

2. 'Tis from the Shade or Penumbra of the Moon interpos'd betwixt the Sun and Earth.

3. 'Tis only seen by Day, or near it.

4. It only happens in the visible Conjunction.

5. It doth not appear in the whole diurnal Hemisphere; but to some it is greater and longer, to some it appears less and shorter, to some it appears total or annular, to others horn'd, or none at all.

6. It begins in the *Western* Margin of the Sun, and ends in the *Eastern*.

7. If the visible Latitude be *North*, the obscured Part of the Sun in the Middle of the Eclipse tends to the *North*, if *South* towards the *South*.

8. Its greatest Duration is when the Sun is in *Apogæo* and Moon in *Perigæo*, about three Hours in one Place and five Hours in different Places.

9. It

9. It happens oftner than the Solar Eclipse in the same Place. 9. It happens oftner than the Lunar in divers Places.

10. In the same Year there cannot be above 3 Eclipses of the Moon. 10. In one Year there cannot happen above 3 Solar Eclipses.

In half a Year's Time may happen two central Eclipses of the Sun, or almost central, and then all that Year will be no Lunar Eclipses.

In no Year will happen less than two or more than eight Eclipses. The Total Eclipses of the Sun are more than the Total Eclipses of the Moon.



SECTION V.

A new and ready Way to calculate the Motions of the Planets, for any Time past or to come.

For the Sun. Add 1 Minute 56 Seconds to his Place 4 Years before the given Time, and the Sum is his exact Place for the given Time; so you may rise to any Year to come, by this proportionable Addition; and likewise look back to any Number of Years; for the Time past, by deducting one Minute 56 Seconds for every fourth Year.

For the Moon. Look in an Ephemeris for twelve Years before, and if you would know the Place of the Moon for the 1st of January, see the Place of the Moon the 27th of February 12 Years before, and add four Signs 1 Degree 5 Minutes to the Moon's Place that 27th of February, and the Total is the Place of the Moon on the 1st of January, desired. so shall you be sure to have the Moon's Place within a few Minutes (when it differs most from the Calculation by the Tables) but for the most Part it will not differ at all; and thus proceed from Day to Day.

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Day out of the old Ephemeris, adding still 4 S. 1 Degree 5 Minutes, and write it against the answering Days of the new Ephemeris successively.

For Saturn. 1 January 1669, I take an Ephemeris for 29 Years before, viz. 1640, then compute the Distance of *Saturn* from the *Sun* on the last of *December* in the Ephemeris for this Year 1668, and having done this, I run my Eye up and down in the Ephemeris 1640, in the Beginning of *January*, or else in the End of *December* 1639, 'till I find *Saturn* at the same Distance from the *Sun* that he is the last of *December* 1668; then I consider his daily Motion from that Day to the next, and the same I allow him from the last of *December* to the first of *January* 1668, and so from Day to Day, allowing him more or less for his daily Motion, according as I find the Motion of *Saturn* either increased or diminished in the old Ephemeris at the same Distance from the *Sun*.

For Jupiter. Take an Ephemeris for 12 Years before, or 83 Years before, and do as for *Saturn*, considering the daily Motion of *Jupiter* in the old Ephemeris, at the same Distance he is that Day that you desire to know his Place for.

For Mars. Take an Ephemeris for 79 Years and do in like manner.

For Venus. Take an Ephemeris for 8 Years and do so.

For Mercury. Take an Ephemeris for 13 Years and do so.

Omne bonum melius quo communius.

Questionless, much more may be done, to which I hope the Ingenious will be prompted on by this Essay.



SECTION VI.

A Table of all the visible Eclipses of Sun and Moon, from the Year 1730 to 1760, under the Meridian of London,
Year

Year	Mon	D.	H.	M.	Long. ☾	☾		☾		Digits			
						D.	M.	D.	M.	D.	M.		
1730	Jan.	22	15	34	Ω	14	10	0	46	S	A	2	53
	July	3	15	26	♄	22	15	0	15	S	A	6	7
1731	June	8	13	55	♄	28	4	0	55	S	D	1	52
1732	Nov.	20	9	59	♄	10	2	0	3	N	D	20	48
	Dec.	5	21	12	♄	25	48	0	32	N	A	0	1
1733	May	2	6	37	♄	22	52	0	8	N	D	9	20
	May	17	6	56	♄	8	17	0	32	N	A	8	25
1735	Sep.	20	13	33	♄	8	18	0	39	N	D	5	37
1736	Mar.	15	11	52	♄	6	39	0	1	N	A	21	45
	Sep.	8	14	24	♄	27	19	0	1	S	A	20	32
1737	Feb.	18	3	4	♄	11	9	0	39	N	D	10	55
	Aug.	28	15	44	♄	16	22	0	42	S	A	4	34
1738	Aug.	3	23	3	Ω	22	14	0	21	S	D	4	8
1739	Jan.	13	10	54	Ω	4	38	0	37	S	D	6	22
	July	24	4	23	♄	11	39	0	12	N	D	7	6
	Dec.	18	20	49	♄	8	19	0	27	N	D	2	10
1740	Jan.	2	10	25	♄	23	10	0	1	N	A	20	29
	Dec.	21	11	49	♄	11	46	0	40	N	A	5	49
1743	Off.	21	15	35	♄	9	17	0	1	S	D	21	30
1744	Apr.	15	8	32	♄	6	51	0	35	S	A	8	0
1746	Aug.	19	12	5	♄	7	18	0	39	S	D	6	6
1747	Feb.	13	17	2	♄	6	18	0	5	S	A	19	42
1748	July	13	22	30	Ω	2	38	0	4	N	D	9	53
	July	28	11	34	♄	16	32	0	49	N	A	4	38
1749	Dec.	12	8	8	♄	2	14	0	44	N	D	4	36
	Dec.	27	21	12	♄	18	6	0	13	S	D	7	9
1750	June	8	9	9	♄	28	16	0	15	S	D	16	9
	Dec.	1	18	31	♄	21	13	0	3	N	D	21	6
1751	May	28	13	58	♄	17	44	0	28	N	A	10	8
	Nov.	21	9	47	♄	10	35	0	39	S	A	8	18
1753	Apr.	6	6	20	♄	27	52	0	45	S	D	5	14
	Off.	14	21	59	♄	3	10	0	11	S	A	8	3
1755	Mar.	16	12	12	♄	7	59	0	42	S	A	7	13
1757	Jan.	23	19	6	Ω	15	48	0	38	S	D	6	43
	July	19	11	53	♄	7	51	0	30	N	D	11	32
1758	Jan.	12	18	13	Ω	4	20	0	1/2	N	A	21	27
1759	Jan.	1	19	46	♄	22	55	0	39	N	A	6	41
1760	May	18	9	35	♄	8	51	0	52	N	D	0	47
	June	1	19	22	♄	22	36	0	20	S	D	4	35
	Nov.	11	9	48	♄	1	8	0	44	S	D	6	30

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Table of the Planets Distances, Eccentricities, Revolutions, &c.

☿	♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓	♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓
953809	520110	152369	100000	72333	38740																			
54709	25050	14100	1732	517	7970																			
2 30	1 20	1 52	66 31	3 24	6 54																			
10719	4332	686	365	244	87																			
6 36	12 20	23 27	6 8	16 49	23 15																			
26	35	30	30	24	53																			
—	9 56	24 40	23 56	23 00	—																			
7 28	5 9	4 1	8 8	9 5	7 13																			
30	50	12	20	08	48																			
2 22	2 8	00 19	00 15	1 15	00 15																			
90	00	10	16	42	10																			
30	40	—	—	10	5																			
6	2	1	1	1	6																			

Mean Distance of the Sun.

Eccentricity.

Inclination of the Orbit.

Periodical Revolution.

Motion about the Axis.

Sydereal Longitude.

Aphel. Longitude Axis Node.

Apparent Semidiameter.

Heat.

If one Direction, Station and Retrogradation of a Planet be compared with another Direction, Station and Retrogradation, they will be found unequal to each other, not only with respect to the Arches in the Ecliptic, but also with respect to their Time, and this Inequality is greater in *Mars* than in *Jupiter* and *Saturn*; then chusing a Mean betwixt the said Inequality,

	♂	♂	♂	♀ and ♀	
The direct Pro-					
gressions of	244	284	705	542	93 Days.
Stationary.	8	4	2	1½	½ Days.
Retrogradations	136	119	75	42	22 Days.
♂ } is Stati-	betwixt □ and △ Aspects with ☉ } in △ Aspect with ☉ } when betwixt ½ and ¾ distant of ☉ }				
♂ } onary					
♂ } when					



SECTION VII.

Of Time, and the Division thereof.

A Year is sometimes taken for the Time of the Revolution of a Planet through the Zodiac, in which a Month is sometimes called a Year.

Another different Year is the entire Revolution (apparently) of the fix'd Stars, through the Zodiac, which they call the *Annum Magnus*. But a Year is properly, that Time which the Sun takes to run thro' the Zodiac in, and is of two sorts, the one Astronomical, the other Civil: The Astronomical is twofold, according to the two different Bounds of the Sun's

Sun's Revolution; namely, *Sydereal* and *Tropical*, the *Sydereal* Year is the Space of Time that the Sun having departed from a fix'd Star returns to the same in; and it is 365 Days, 6 Hours, and 9 Minutes nearly. The *Tropical* Year is that wherein the Sun departing from one of the Cardinal Points, the equinoctial or Solstitial returns to it again, and is somewhat less than the *Sydereal*, because the Cardinal Points of the Ecliptic themselves go backwards, and as it were meeting the Sun. This *Tropical* Year is 365 Days, 5 Hours 49 Minutes, 26 Seconds nearly, and wants about 26 Minutes of the *Sydereal*.

The *Civil* Year is the Space of Time that the Motion of the Sun or Moon, or both, point at, received by the settled Custom of any Nation or Country. There are three Forms of the *Civil* Year, viz. Either purely *Lunar*, or purely *Solar*, or *Lunar-Solar*, which is made up of both. The *Lunar* Year consists of twelve Lunations, or *Synodical* Months, that are finished in 354 Days, then begins again, this Year wanting near 11 Days of the *Tropical* Year, would wander through all the Seasons of the Year in about 33 Years; This sort of Year is used among the *Turks*.

There are three sorts of *Solar* Years, or such as are fitted to the Motion of the Sun alone, and the Vicissitudes of the Seasons depending thereon; the *Egyptian*, *Julian* and *Gregorian*; the *Egyptian* Year consists of 365 Days, which they divide in 12 Months, of 30 Days each, and 5 Days to be added at the End; this Year wanting near 6 Hours of the *Solar-Tropical* Year, in 4 Years it gets near a whole Day before it, and in 1460 Years its Beginning wanders through all the Seasons of the Year.

Julius Cæsar finding this Year to want 6 Hours, he added the Day made of them in every 4 Years between the 23d and 24th of February. This *Julian* Year consisting of 365 Days, and every 4th Year of 366 Days, is best fitted for *Astronomical Computations*; because

Because it is a Mean between the Natural or Tropical Year of 365 Days, 5 Hours, and 40 Minutes; and the *Sydereal* Year of 365 Days, 6 Hours, and 9 Minutes. This Year was held *common* among all polite Nations, from *Augustus* (who restored it when almost lost) untill the Year 1582, when the *Julian Kalendar* was reformed by GREGORY XIII; but it is still in use by us in *Britain* and *Ireland*, &c. Yet it must be confess'd, the Quantity of our *Julian Year* is too big, on which Account the Beginning of the Year creeps forward in regard of the Seasons, or (which is all one) the Equinoxes and Solstices creep backwards, in regard of the Days of the Year. And since this Regress is about 10 Minutes, 20 Seconds, in about 133 Years it will be a Day; and consequently from the Year of Christ, 3253 wherein the Council of *Nice* was held, to the Year 1582, wherein the Pope reformed the Kalendar, namely, 1260 Years, this Regress was 10 Days. Hence it comes to pass, that whereas the Vernal Equinox happened about the 21 Day of *March* in the Time of the *Nicene* Council, in the Year 1582. it crept to the 11th, and this Year 1730. It's on the 9th Day, differing from the Ecclesiastical Vernal Equinox (which is the 21st of *March*) 12 Days, which Variation is caused by our *Julian Year* exceeding our *Solar Year* by 11 Minutes, *near*.



SECTION VIII.

On Easter.

OBSE R V I N G of late, a vast Difference between our Ecclesiastical *Canons* thereupon, and the applying the celestial Full Moons and Equinoxes, I shall take this Opportunity to impart my Thoughts thereupon, to satisfy the *Curious* therein.

The

The *Nicene Council*, Anno 325; decreed *Easter-Day* to be that *Sunday* which falls next after the first Full Moon, that happens after the Vernal-Equinox, which we pretend to follow and explain in our *Rubrick*, where we design *Easter-Day* to be always the first Sunday after the first Full-Moon, which happens next after the one and twentieth Day of March; and if the Full-Moon happen upon Sunday, *Easter-Day* is the Sunday after, Which last needs Amendment, for instead of the Sunday after, I suppose it should be that very Sunday, according to both the Tables in the *Common-Prayer*; and the rest of it also needs further Illustration from the following Remarks.

1st, That the Ecclesiastical Vernal Equinox is still fix'd to the 21st of March, tho' the true, is now about the 9th or 10th, which Variation is caused by our *Julian Year* exceeding our *Solar* by 11 Minutes near.

2^d, That the *Paschal Full Moon* happens still on the 14th from the *Paschal new*, i. e. but 13 Days compleat.

3^d, That the Words next after the 21st, include that Day as certainly here, as in a few Lines after *Ascension Day* is said to be 40 Days after *Easter*, includes *Easter-Day*.

4th, That the *Paschal Full Moons*, which we observe are near 5 Days later than those of the Heavens, because they have lost an Hour and a half every nineteen Years, since that general Council.

5th, The *Paschal New Moon* is bounded with March the 8th and April the 5th, the *Paschal Full Moon* with March the 21st and April the 18th; and *Easter-Day* with March 22^d and April 25th, on which Limits, tho' they may happen, yet never can exceed them.

6th, Till the *Kalendar* be reformed, we are not to regard the Celestial Equinoxes, Lunations, or Full-Moons as they happen in the Heavens now-a-days. But the reputed Ecclesiastical Equinoxes, Lunations and Full Moons as they indeed happened in the Time of the *Nicene Council*, about 14 Centuries ago, which we obtain

tain by the Directions of the old *Primes*, in the Ecclesiastical *Kalendar*, which here follow.

The Use, having the Prime and Dominical-Letter, to find EASTER.

IN the first Column quickly see,
Look out the *Prime*, where e'er it be,
The third *Sunday* after, *Easter-Day* shall be.
And if the *Prime* on *Sunday* be,
Reckon that for one of the Three.

}

Prim.	Mar.	D. L.	Prim.	April.	D. L.
16	8	D		1	G
5	9	E	11	2	A
	10	F		3	B
13	11	G	19	4	C
2	12	A	8	5	D
	13	B	16	6	E
10	14	C	5	7	F
	15	D		8	G
18	16	E	13	9	A
7	17	F	2	10	B
	18	G		11	C
15	19	A	10	12	D
4	20	B		13	E
	21	C	18	14	F
12	22	D	7	15	G
1	23	E		16	A
	24	F	15	17	B
9	25	G	4	18	C
	26	A		19	D
17	27	B	12	20	E
6	28	C		21	F
	29	D		22	G
14	30	E	9	23	A
3	31	F		24	B
			17	25	C

Example 1st, Suppose the *Prime* 8, Dominical-Letter C. The *Prime* is against *April* the 5th, the first *Sunday* after is the 11th Day, the second *Sunday* is the 18th Day, the third *Sunday* is the 25th. for *Easter-Day*.

Example 2d, Suppose the *Prime* 16, Dominical-Letter D.

The *Prime* stands against *March* the 8th on *Sunday*, the second *Sunday* is *March* 15th. the third *Sunday* is the 22d of *March* for *Easter-Day*.

But if any ignorant of the Ecclesiastical Full Moons, shall apply in their Room the celestial Lunations and Equinoxes, they will find the Difference sometimes not only of Days but Weeks: nay, a whole Month: As in 1720. 1723, 1747, 1750. 1774, 1777. (When *Easter* falls high, and the *Epass* very little or very large) and if no Reformation be, the Error will be 6 Weeks, Anno 2437, and after 2698 *Easter* will never happen according to the Decree of the Nicene Council.

146 *Of the Equation of Time, &c.*

To conclude, I shall humbly propose to the Consideration of my learned and judicious Superiors, a brief easy Way to reconcile the Kalendar to the Heavenly Motions as they were at the Beginning of our Christian *Era*, without Confusion in the Dates of our Civil Contracts. &c.

For the Term of fifty-two Years to come, omit all the *Bissexiles*, which will be thirteen Days: This alone would gradually and insensibly, without the least Inconvenience, bring us two Days before the *Gregorian* Account, and be agreeable to the Sun's Motion at our Saviour's Birth, and cause the Festivals to be kept according to Primitive Observation. after which fifty-two Years, observe the Leap-Years as usual, till even Centuries as 1800 and 1900, count common Years; but 2000 make a Leap Year, and every fourth Century ensuing, which will prevent the Variation of one whole Day in 10000 Years.



SECTION IX.

Of the Equation of Time; and to regulate Clocks and Watches.

HOW beneficial and necessary Pendulum Clocks and Watches are in the Affairs of Human Life, 'tis needless to relate: But something respecting their right Use and Mathematical Understanding of them, may be acceptable to several.

The Clocks I here mean, are such as are made by a skilful Workman; for a Piece ill made, may vary from the equal Time a Quarter of an Hour in a Month.

Month. Whereas a Piece made by a judicious Hand will not err a Minute in the same Time, if truly adjusted. As to the Exactness of these long and weighty Pendulums, we are by many curious Experiments sufficiently satisfied, that they are the most steady of all Artificial Motions, yet it will not point out by the Index, continually the same Time given by the Sun on an exact Dyal, but in a few Days we may be sensible of the Gain or Loss betwixt the Dyal and Pendulum Clock; now this Disagreement is not occasion'd by any Defect of the Clock, but proceeds from a two-fold Inequality in the Heavenly Motions; to wit, the Eccentricity of the Orbit of the Earth, and the oblique Position of the Equator to the Ecliptick.

As to the first; we may observe, that if the yearly Orbit were indeed circular, and had the Sun in the Center; so that the Distance of the Sun from the Earth should be always the same, no Cause of this Inequality would be found in the Figure of the Earth's Orbit: But in the Elliptical Orbit, where the Quantity of the diurnal Motion is unequal, and diverse in some Days from what it is in others, the Thing must be necessarily otherwise; unequal Portions being continually added to the diurnal Revolution. As for Instance; in the *Aphelia*, the Earth by its slower Motion doth daily change its Angular Position to the Sun less than it doth in the *Peribelia*, and consequently the Angle is less, which it doth then finish over and above its entire Revolution, to be added to that Revolution, that so the Solar Day may be completed; for the diurnal Motion, which as to the superior Focus of the Ellipsis, is always nearly equal, is considerably unequal, with respect to the Sun near the inferior Focus; and thus an Inequality must needs be introduced into the Natural Days.

The other Cause of the beforemention'd Inequality, is the oblique Position of the Equator to the

Ecliptic. If the Axis of the Earth were always moved Parallel to the Axis of the Ecliptic, and consequently the Plane of the Equator had coincided with that of the Ecliptic, there would be nothing in the Earth's Position, with respect to the Ecliptic, that might cause this Inequality. But when the Diurnal and Annual Motions are performed on very different Axes, then an Inequality of Days must necessarily take Place. For in this, the Sun's Longitude along the Ecliptic, and the diurnal Motion along the Equator, which we call the Sun's Right Ascension, are both taken into the Account; and unless every Arch of the Ecliptic answered to every equal Arch of the Equator, so that there were no Difference betwixt the Longitude of the Sun and his Right Ascension, which Thing cannot be; there must most certainly an Inequality of Days arise from thence, *E. G.* Let the Longitude of the Sun be five Degrees, his right Ascension then must not by Trigonometry, exceed four Degrees, thirty-five Minutes, and a Quarter, which wants twenty-four Minutes and three Quarters to be equal with the Sun's Longitude: This Defect of twenty-four Minutes, forty-five Seconds turned into Time, comes to one Minute and forty Seconds *fere* which Space, tho' in it self may seem small, yet when it is augmented for many Days successively, by an almost equal Increase, will introduce in a while an Inequality too great to be neglected.

Both the Quantity and Place of these two Causes of the Inequality here mentioned, are very different in this our Age, and require to be distinctly calculated. Now the former of these Causes, to wit, the Eccentricity of the Orbit, which differs wholly from the latter, remits us to the *Aphelia* and *Perihelia* for an Equation of Time, which answers to the Quantity of that Eccentricity, and is once a Year to be added to the apparent Time, and once to be subtracted from it. But the latter of these Causes
which

which is plainly different from the former, makes an Equation of Time equal to the Difference betwixt the Sun's Longitude in the Ecliptick, and his right Ascension in the Equator; and which being to be reckoned from the Equinoxes to the Solstices, and from the Solstices to the Equinoxes, is twice a Year addititious, and twice ablatitious, and is almost one and an half of the Eccentric Equation.

The whole Equation therefore of Solar Days is not to be gained from either of these Causes single or alone, but from the Combination of both, for where both the Equations are addititious, or both ablatitious, the absolute Equation of Time ariseth from the Sum of them, which is to be added to or taken from the true Time, according to the Tenor and Name of both the Equations; and where one is addititious (or to be added) and the other ablatitious (or to be taken from) thence for the obtaining the mean or even Time, the Difference of them is to be added to or taken away from the true Time, according to the different Time of the Year and Title of the greater.

From this we may plainly observe, that there is a Necessity of this Equation of natural Days, seeing it is founded on true Astronomical Principles, and proved by correct Observations. I shall in the next Place apply it to Practice in regulating curious Clocks. First, we must observe that a Pendulum Clock goes equal, that is, one twenty-four Hours at any Time of the Year, is as long as another twenty-four Hours at any other Time of the Year; and this is perpetual and constant, and therefore ought to differ from the apparent Time shewn by a Sun-Dial or other Instrument, as much as is the Equation of Time in Excess or Defect. Thus, you may see by the Table, that there are only four Days in the Year on which the Equation of Days ceases, that is, the apparent and mean Time are

then the same, viz. April 4th, June the 6th, August the 21st, and December the 13th. If on any of these we set a well regulated Pendulum Clock to the apparent Time shewn by the Sun, on any Day afterwards, it ought to differ from the Sun so much as is the Equation of Time by the Table. if the Equation is to be subtracted, the Pendulum ought to be so much slower than the Sun, and if the Equation is to be added, the Pendulum ought to be so much faster than the Sun.

Thus, if at any Time you desire to adjust your Clock, and bring it to measure the equal Day, you must either add or subtract the Equation of that Day to the apparent Time given by the Sun, and set the Clock to it. For Example, the Year 1720, Jan. 1st, at Noon (*the apparent Time, or true Noon being found by a Dial, or true Meridian Line*) in the Table of Equation, I find eight Minutes, forty-seven Seconds, with Title Add, wherefore I set my Clock eight Minutes, forty-seven Seconds past Twelve; and observe the third Day if it be nine Minutes, thirty-two Seconds faster, then the Clock goes well; but if it goes too fast, screw down the Bob, till it gain, as in the Table (at that Time of the Year) and if it go too slow screw up the Bob, till it agree in going with the Table. Therefore your Clock must always go so much faster or slower, as the Equation in the Table, agreeing with the Time of the Year.

Those Pendulum Clocks by Experience is found, Whose Swing in a Minute makes sixty Rebounds, (As by Tryal you'll find) if you measure their Lengths, Will contain just thirty-nine Inches, two Tenths; If so, then how long must that Pendulum be That shall make the same Number of Swings to agree With the Number of Inches its Length doth contain, In the Space of a Minute, I'd know very fain.

Answer.

Answer. According to *Ricciolus*. Reciprocal Pendulums are to each others Length as the Squares of their Vibrations in the same Time. Therefore Inches 52.06303591625108271 which is the Cube-Root of the Product of 39.2 multiplied by the Square of 60 . is the true Length of a Pendulum, the Number of whose Vibrations (in one Minute of Time) and Inches shall be equal to each other.

Divide 141120 the Product aforesaid, by any given Length, the Quotient is the Square of the Number of Vibrations sought. Or,

Divide 141120 aforesaid, by the Square of the Number of Vibrations given, the Quotient will be the Length of the Pendulum sought, thereunto belonging for one Minute.

Moreover, the Length of a Pendulum vibrating Seconds at *Paris* is three Feet eight Lines and an half; let it be required to find the Length of a Pendulum vibrating Seconds at the Equator.

Because the Gravity at the Poles is to the Gravity at the Equator as 692 to 689 , therefore the Decrease of Gravity at the Equator is $\frac{3}{797}$ Parts of the whole Gravity; but the Decrease of Gravity at the Equator is to its Increase in any other Latitude, as the Square of Radius is to the Square of the Sine of the Latitude: as 1000000 Square of Radius to 565248 , Square of the Sine of the Latitude 48 Degrees 45 Minutes Latitude of *Paris*, so is 3 the Number which represents the Decrease of Gravity at the Equator to 1.695 the Number which represents its Increase at *Paris*, which added to 689 , the Gravity at the Equator. makes 690.695 the Gravity at *Paris*.

Then as 690.695 Gravity at *Paris*,

To 689 Gravity at the Equator,

So is 36.708 Length of a Pendulum at *Paris*,

To 36.616 Length of a Pendulum at the Equator.

The Difference $\frac{92}{7975}$ Parts of an Inch agreeing pretty near to the Observation of *Monfieur Richer*, who

who at the Island of *Caen*, whose Latitude is five Degrees, found that a Pendulum there was $\frac{5}{10}$ of an Inch shorter than at *Paris*.



SECTION X.

To discover a Ship's Distance at Sea, and to know when you have cross'd the Line or the Poles, were it possible.

IN sailing near Land, if you spy two Lands, whose Distance you know, and they bear off you one Point distant asunder, when you are athwart them you are five Times their Distance from Shore, if they bear two Points, then are you 2 times and an $\frac{1}{2}$ their Distance, if 3 Points, then 1 and $\frac{1}{4}$, if 4 Points, then the same Distance, if 5 Points, but $\frac{2}{3}$ of that Distance, if 6 Points, then but $\frac{1}{2}$ their Distance.

To know when you have cross'd the Equator.

Observe if you can see *Charles's Wain* and the Guards, or Circumpolar Stars, then is the North Pole elevated; or if you look towards the Equator, you shall see the Stars ascend from the Left towards the Right, if in North Latitude; but from the Right towards the Left, if you be in South Latitude.

To know whether you are going to or from the Poles.

Seeing from the North Pole all Places bear South, and near the Pole the Compass is of little Use; then get a good Clock, mark'd with 24 Hours, and

an Index which shall every Noon return to 24 then when under the Pole, look and see if the Index point at 24, then that Point where the Sun is, is directly back again from the Pole,

If 12, then towards the Sun is right forwards.

If 6, then towards the Sun is Earth due West.

If 18, then towards the Sun is Earth due East.

Wherefore, to go directly homeward, because I came out North and must return South, I lay the Fly of the Compass steady before me, and the South Point right with the Ship's Head or Stem, then if the Clock point 24 Hours, then I steer the Ship directly upon the Sun.

But if the Clock point	{	3	{	Then he that doth steer, must keep the Sun	{	South West.
		6				West.
		9				North West.
		12				North.
		15				North East.
		18				East.
21	South East.					

But if you would go directly forward, then lay the North Point right with the Ship's Head, and when the Clock doth point 12, steer right upon the Sun.



As an EPILOGUE to this Mathematical Miscellany, I shall subjoyn some few Paradoxical Questions, which whoever shall send the true Solution of before 1731, to the Bookseller at the Globe in Meath-street, he shall have his Chance, by Lot, to win a Dozen of these Tracts, next New-Year's Day, to oblige his Friends with.